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GEOGRAPHY.

BY

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Translated for the Use of Schools and Colleges,

BY

WILLIAM L. GAGE.

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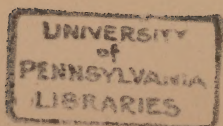
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TRANSLATOR'S PREFACE.

THE translator of Ritter's "Geographical Studies," which has received in its English dress the hearty greeting of our most cultured scholars, takes a renewed pleasure in giving to the students of our higher Seminaries a second volume from the pen of the great Geographer. The former work, addressed, as its contents mainly were, to the members of the Royal Academy of Berlin, was too recondite in thought and too abstruse and elaborate in statement ever to become, whether in German or in English, a popular work; but the present volume—the bright, compact crystal of Ritter's life—will pass into a general circulation, and will be recognized as not merely a simple and perfectly intelligible treatise, but as a masterly application of the comparative method of Geography, and as philosophical as it is practical and interesting.

Besides the voluminous *Erdkunda*, which deals almost exclusively with Asia, and treats it with an exhaustive fullness, Ritter has left the world the volume already referred to, and three courses of Academical Lectures. One of these courses is now before the reader; one of the remaining two relates to the geography of Europe, and the other to the history of Geographical Science and of Discovery. Of these three courses, a distinguished American scholar* has said: "Free from excessive details, systematic, clear, bold, and fresh, they are better fitted to bring up to the mind Ritter, the university instructor, than all his other writings." This praise is by no means excessive; and the student who shall, with the assistance of a good physical

* Prof. D. C. Gilman, of Yale College.

atlas, go through this work, will find himself master of a far larger number of special facts than the size of the volume would indicate; and also of a *science* of Geography, which subsidizes all detail, and makes it auxiliary to the comprehension of relations no less beautiful and singular than are revealed in the study of the other departments of Nature.

The peculiar difficulties attending the translation of the Geographical Studies have not been met in this volume; in the University lecture-room, Ritter's style, which, before the Royal Academy, was extremely involved, poetical and inexhaustive, became simple, straightforward, and luminous. In style, Ritter carried neglect to the point of slovenliness; and the finish which Humboldt cultivated so assiduously, he rejected as unworthy of a true scholar. The highly figurative words with which he used so liberally to decorate his writings, I have generally had to render with a rather too bare fidelity to a prose style; for grateful and captivating as they were to his German hearers, they would look over-fanciful to an English reader, and obscure rather than illustrate the thought. It has been my earnest purpose to make this work fill a great void in our educational literature; and its convenient size gives it an incomparable advantage over the voluminous works of Sir John Herschel and Mrs. Somerville; while in rigid philosophical precision, in method, in natural growth—not to use that inevitable German word *development*, (*Entwicklung*)—even those eminent geographers would, doubtless, award it the palm.

The demands of the public may yet render needful the translation of other of Ritter's works; meanwhile, the editor of this work purposes to prepare a biography of that great man, whose memory all his pupils revere, and whose life was not less beautiful to his friends than it was fruitful and valuable to the whole scientific world.

W. L. G.

July 5, 1864.

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INTRODUCTION.

THE subject of these lectures is Geography in its most enlarged and comprehensive sense. It will be necessary to preface them with some general observations, which shall serve to indicate the scientific basis on which the discussion will rest. Our starting-point will be with Nature herself and not with arbitrary geographical systems hithert constructed.

By the word Nature will be meant the entire Creation. The grasping of Nature in all its objects and all its forces becomes, in conjunction with the agency of Time and Space, the comprehension of a great system. The inanimate creation may be represented under the term inorganic, the animate creation under the term organic. Yet there is not an absolute contrast between them; for in both there is ceaseless progress, no pause, but in a higher and comprehensive sense a cosmical life, the whole forming one great Organism, in which the inorganic world, so called, is only the foundation on which the animate creation stands.

To us, our own Earth is the most marked feature of Nature viewed on its inorganic side. To us it is the planet best known of all, or rather the only one closely known, the point whence we draw conclusions on the whole Universe, the resting ground for the glass that searches the Kosmos, to use Humboldt's word, discerning the place which the Earth holds in it, and prying into the mysteries of the entire creation. Our globe is one of the major planets of our system, all of which gird the sun with great elliptic orbits, midway in which is our own. There begins the first popular division of the planets,—those that are within and those which are without our own orbit. This is one of the most simple of discriminations, one which we inherit from the ancients in an unmodified form. Humboldt retains this primary classification.

The external planets are those whose orbits embrace that of the Earth within their own. The minor planets are those whose orbits are embraced by that of the Earth. These are Mercury and Venus.

The ancients, counting both the sun and moon, reckoned only seven planets. At the end of the eighteenth century another was added, Uranus, an external planet. Through the instrumentality of improved telescopes, soon after, four minor ones were discovered, Ceres, Pallas, Juno, and Vesta; and by the still more perfect lenses recently introduced, and the assiduity and skill of astronomers, the number of these little planetary bodies, ranging between the orbits of Mars and Jupiter, has grown great. Beyond Saturn and Uranus is Neptune, discovered mathematically by Le Verrier, in Paris, and seen by Galle in Berlin, the 23d of September, 1846.

To these (now eighty) planets may be added the twenty to thirty moons of our solar system, and a number of comets.

The middle position of the Earth's orbit is not without its consequences. The distance of the Earth from the Sun is, in round numbers, 92,000,000 of miles, nearly three times as far as that of Mercury, the planet nearest the Sun. Jupiter, on the other hand, is five times as far from the Sun as the Earth; Uranus about nineteen times as far, and Neptune about thirty-three times as far.

The time of the Earth's revolution around the Sun is also equally removed from the extremes; its year is 365 days; Mercury's being 87 days; Jupiter's 11 of our years; Uranus 84 years; and Neptune's 165 years.

The daily revolution of the Earth on its axis is also of only medium swiftness, consuming 24 hours. This, of course, controls the periods of waking and sleep of the entire animate creation on our globe. Some planets revolve slower, some more rapidly than our own; Jupiter's revolution, for example, is accomplished in little less than 10 hours. This extreme rapidity seems to account for the much greater flattening at the poles of the planets than the Earth exhibits, occasioned doubtless during the formation processes, while those immense revolving masses were passing from their primitive fluid state into the more rigid forms in which we know them. Of all the planets, however, the Earth has most perfectly retained the spherical shape; and the spherical form is in one sense a *medium* form; *i.e.* it is removed from all extremes of angularity, and so falls in with the analogies which I am endeavoring to establish, springing from

the position of the Earth's orbit *midway* between those of the inner and outer planets. According to Plato, the beauty of form lies in symmetry, and our Earth is the most symmetrical of planets, and, unquestionably, the spherical shape is the one best adapted to the display of the largest number of phenomena possible.

The variations from the spherical form, produced by elevations and depressions, are only of medium magnitude in our globe compared with many others in our system. On the smaller planet of Venus, for example, the mountains are thought to rise to a height of many miles, while five is the greatest altitude of ours. According to Mädler's conjectures, the mountains in our own moon rise to a height of over three miles, an altitude altogether out of proportion to the size of the moon as compared with the earth.

In respect to the number of its moons, too, our Earth is no extremist; it has but one: other planets, Mercury, Venus, Mars, have none. On the other hand, Jupiter has 4, Saturn 7, Uranus 6 at least, and doubtless more. The general law seems to be, the farther from the Sun the greater the number of moons; perhaps in the wonderful providence of God, to compensate the feeble light of those distant realms by the number of the reflecting bodies.

Now, summing up all that has been said, it will be seen that the Earth is equally far removed from every extreme. This fundamental classification, drawn from the place of its orbit in relation to those nearer the Sun or more distant from it, gives it a character which is felt and seen in many different things, and responds to analogies which it is not incorrect to mark. A *medium* is seen in all its attributes and relations: it is neither the largest nor the smallest of planets; neither the swiftest nor the slowest; neither the warmest nor the coldest; in nothing is it either at a minimum nor at a maximum point. And this very medium character brings the Earth into harmony with the system of which it forms a part; the symmetry of the one corresponding with the symmetry of the other, and specially fits it to become the temporary home of a race like ours, which makes the whole surface of the globe tributary during the short terrestrial life of man to his preparation for a celestial state of being. Our globe is certainly the only one of our system which could possibly be inhabited by man; and as his residence, and as the arena for his culture, it is worthy of being studied in all its features; no point is too trifling to be overlooked.

As man looks for a center to the system which *evidently* pertains to him, and in which our Earth plays no slight part, the Sun is clearly the source of a large share of what makes our life desirable. Thence we receive light, warmth, and indirectly, and yet directly too, life and the bloom of health. Nor can men, even if ignorant and degraded, *help* seeing the relation of the Sun to the Earth, and linking, in their rude thoughts, the heavens with the earth; and hence, before all higher Revelation, the worship of the Sun has been the primitive instinct of the oldest of nations.

Looking at the earth as simply one among the innumerable hosts of heaven, it, like each one of them, becomes to the imagination a mere point of light, a "star among stars." But, when we shift our point of view, and leaving the cosmical or universal for the special, for what pertains to the individual life, the mere point of light flames up into a great, busy world, full of phenomena demanding investigation and thought. And yet this world, so attractive in its multiplicity of details, is almost a chaos at the first sight; a confused and inextricable mass, so large, so high, so deep as to defy human effort to compass or master it. Science alone, the gift and the growth of centuries, can measure the field; science alone can enter it and reduce the chaos to a beautiful and orderly grouping, and make a perfect picture of the whole; it alone can dispel crude ideas and give truer ones in their stead. To the rude dweller on the plain, the earth seems a gigantic floor, as it did to many a tribe in the past, and as it does to-day to thousands of wondering Arabs. The South Sea Islander, in the Pacific, takes his island or island group to be the whole earth; the world he considers an endless ocean plain, from which the Sun arises, and, when the day is over, into which it sinks. And even within the pale of civilization itself, the ignorant Neapolitan lazzarone considers his gulf the center of the world.

As men advance in their inquiries, and, ascending the sides of mountains, look out over a larger tract, or find new lands across the seas, they do not outgrow their first idea, the world merely expands from the narrow homestead to a larger circle, such as the Romans used to call their *orbis terrarum*. The conception of the earth as a vast, unsupported ball, careering through the heavens, was the possession, slowly won, of such great minds as Pythagoras and Aristotle, and slowly found its way among the ideas which

whole nations accepted as true. Circumnavigators must sail around the globe and tell their story to the world before the conjectures of science could have real weight with the popular mind in a matter so remote from the crude speculations of the ignorant as this. And less than one century and a half ago (in 1727) another step was taken, and the theory was propounded by Newton, that the Earth is a spheroid and not a perfect sphere. Later investigations have determined that the spheroidal form is only an approximation to perfect accuracy, and that the Earth is a polyhedron, whose exact number of zodes has not yet been determined, and which may prove indeterminable. Bessel has assigned, as the great task of science for the coming century, to settle this question with perfect exactness. But what has been said is enough to indicate that in our knowledge, at present, certainly there is only progress, only approximation, no absolute exhaustion of the processes of discovery.

And just as in ruder lands each man looks at his own island, or village, as the center of the earth's circle, so the ancients looked at the earth as the pivot of the universe, the central point around which all the heavenly hosts revolve. That was the fundamental principle of that Ptolemaic system which was older than Ptolemy; held in the most ancient times in Arabia, Babylon, Persia, and India, but first luminously expanded in the proportions and with the dignity of a system by Ptolemy. Its outlines were, in one word, this: there are seven planets, the Moon, Mercury, Venus, the Sun, Mars, Jupiter, and Saturn; each has its own orbit, in which it is in a limited sense supreme, but they all revolve around the common center, the Earth. Beyond the seven, and including them all, is the Firmament, in which the other stars stand like golden nails in an imperishable floor; the whole vast external Firmament is opaque and motionless.

The Ptolemaic system won and held the greatest regard in the ancient world. Mohammed established it in the Koran as a truth of religion. The advance of science revealed the falseness of the Ptolemaic scheme of the universe, and demonstrated the fact that the stars of heaven are not mere torch-bearers for us, and mere interpreters of human destinies, but are worlds like our own, our earth being but one of numberless thousands equally worthy of the Common Creator. The Copernican system, which was to re-create the whole domain of science, wrought this great change. The

Sun, according to this theory, forms the central point around which, and not around the Earth, all the planets wheel. Copernicus, in 1543, left this imperfect and yet fruitful conception to his successors to unfold; and in the results gained by Kepler, in 1631, by Newton and Galileo, 1727, the Copernican system was firmly established. The vast improvements in the telescope removed the limits of the visible universe to a place till then unrevealed, and added inexhaustible fields to those which had been known before. The number of the planets was enlarged. The list of determined comets increases yearly. The number of the fixed stars has been determined by the extreme accuracy of such observers as Lalande, Lacaille, Bessel, Argelander, and Lamont. The great work of mapping and cataloguing the heavens has been accomplished. Many hundred stars, supposed to be single fixed stars, have been ascertained to be double stars, and some have been resolved into systems like our own. The 300-400, observed by Struve, have grown, through the labors of Herschel, in both the Northern and the Southern hemispheres, at the Cape of Good Hope, and elsewhere, to over 3000, and the number is constantly increasing. Nebulæ have been analyzed, and been shown to consist of worlds distinct and perfect as our own. Thus there is a steady and perceptible advance in man's conception of the Earth, of Nature, of what we call the World and the Universe, though each individual, generation, and century are but dimly conscious of this progress.

THE EARTH AS THE DWELLING-PLACE OF MAN.

The Earth draws our attention to itself, however, not as simply a unit in the planetary system, but as the home of the human race. The physical description of the globe includes the relations of the Earth as a star amid the heavenly hosts, while Geography, taken most comprehensively, regards the Earth as the dwelling-place of Man. From a geographical point of view, the world becomes to us the common home of our race, the theater, not of the operations of Nature in the most unrestricted sense, but the arena for the development of human life and history. The whole animate and inanimate creation is tributary, looked at geographically, to the fashioning of the destiny of Man. Without Man as the central point, Nature would have no interest to the geographer; without the Earth, constituted just as it is, the races of men and the course of

human history could not claim his attention. The Earth is not only the best known of planets, but, as the home of man, infinitely the most interesting. The study of it is at the foundation of history as much as of physics.

No man of science can fail to regard it with the deepest interest.

More than a hundred years ago, George Foster remarked that European culture had ascended to that height, that it must include an intimate knowledge of all that is peculiar in the features and phenomena of the entire globe. How much more true is this remark in the middle of our nineteenth century! It is no longer European culture that demands this, but the welfare of all countries claims of scholars this knowledge far more imperatively than a hundred years ago. Still, it must be confessed that we are far from the attainment of a perfect science of Geography, in its largest sense; the science which regards the Earth as the field of human discipline; the science of which what was formerly called Geography is only an outlying, rudimentary part. The compass of what it holds as its goal is too large, and its contents too varied for *his* grasp whose existence is hemmed in by narrow bonds, and whose life is so brief. And though there have always been detailed descriptions of the different parts of the earth, many of them remarkable for their accuracy, yet there has been lacking a knowledge of the principle of organic unity which pervades the whole, and the mutual play and interdependency of all the parts. The whole subject of *relations* was unstudied. And it is a knowledge of the relations of things that leads to a scientific interpretation, not the description of detached parts. Geography was and continued to be mere description, not the teaching of the most important relations. Only now are we beginning to comprehend the true elements of geographical science, only now are the first efforts made to deal profoundly with this science, although the progress of discovery is still going on with unabated speed, leaving far behind us all the advances of our predecessors.

GEOGRAPHY AS A SCIENCE.

The Earth, considered *per se*, is only a fragment of the Universe, of the Kosmos, in that wide use of the word which Humboldt has given to it in his celebrated work. The Earth is the grand floor, so to speak, of Nature; the home, or rather the cradle, of men and of

nations, the dwelling-place of our race. It is not merely a region of immense spaces, a vast superficies, it is the theater where all the forces of Nature and the laws of Nature are displayed in their variety and independencies. Besides this, it is the field of all human effort, and the scene of a Divine revelation. The Earth must be studied, therefore, in a threefold relation: to the Universe, to Nature, to History.

And it is not only as a mere passive agent, but active, that it assumes this threefold relation. It is an inseparable, an integral, a working member in the great system of things. But higher than this, and grander than its relation to the system of *things*, is its relation to an unseen world, to an unseen hand, even that of the Creator. We view it not as the field of forces and laws and phenomena, but the crowning gift of God, displaying the tokens of perfect adaptation to our wants, full of beauty and excellence—a revelation of Divine wisdom, in the form of a visible world. How beautifully has the inspired David painted this in the 104th Psalm!

In relation to its inhabitants, crowned with the Imperial gift of reason, the Earth is not merely the place where they may stand, the cradle where they may sleep, the home where they may live, it is the school where they may be trained. This is one of the first and one of the greatest lessons that we learn from the history of the race. The Earth finds its highest mission, not in its relation to inanimate nature, but to the world of intelligence—the minds that dwell upon it, the spiritual world to which it gives bodies. And as the Earth alone of the planets is adapted to be the home of such a being as man, so in our world of animate and inanimate things, man alone partakes of a moral nature, incapable of being shared or even imitated by the lower creatures. The Earth was made to be the home of mind, soul, character. And Man was created to make this earth tributary to his largest growth in mind, and soul, and character. In this sense the Earth and its noble possessors are correlative. Each individual rises to his own appointed work, runs his own course, uses all the appliances of Nature, all the help with which God invests him, and then ceases from his mission here; but the Earth remains, the home of the advancing millions, helping them all onward, and granting them new power to fulfill the noble purposes of human life.

Nor can this constitution of things be the result of a happy acci-

dent. Evidently under the supreme power of a Divine mind and will, Nature is made subservient to Man. That mutual working and interdependence of things, which opens to our comprehension the History of our race, cannot be ascribed to a fortuitous combination of events. It can only be the result of Divine Providence. Had there been no wise ruling of the blind forces of nature, no subjection of the rough, unbridled powers of the air, and sea, and earth, the human race would have become extinct, as so many races of beasts have done. But there are no traces of the extinction of a human race in our Paleontology. The constitution of the globe is incontestably coincident with a plan to preserve and perfect Man. There are destructive agencies, it is true, but they do not operate on an extended scale; our earthquakes, and volcanoes, and great storms at sea affect but a fraction of the race, they are no longer universal in their action; while, on the contrary, the instrumentalities which favor mankind remain in force—the earth's changeless garment of green, the uniform progress of generation among subordinate creatures, the ease of acclimatization, and of transferring seeds and germs, with undiminished fruitfulness, from one region to another. The very agencies which, in the dawn of history, brought death, have been changed to auxiliaries of life with us to-day.

The investigation into the relations of the Earth, in this respect, and into the organization of all the natural laws and phenomena in their bearing on man, his life and history, must constitute a prominent department of true geographical science. When Geography ceases to be a lifeless aggregate of unorganized facts, and becomes the science which deals with the earth as a true organization, a world capable of constant development, carrying in its own bosom the seeds of the future, to germinate and unfold, age after age, it first attains the unity and wholeness of a science, and shows that it grows from a living root; it becomes capable of systematic exposition, and takes its true place in the circle of sister sciences. Philosophy gladly grants it a share in its own domain, and permits it to indulge in those soaring speculations, which it used to be thought that so simple a thing as Geography might not enjoy. Yet, it must not be denied that there has for some time been felt a need of bringing the earth, as an organization, more into the light of scientific investigation. The study of final causes, the tracing of infinite

wisdom in the works of the Creator, the theories touching the first issue of all things, have grown out of this necessity. Many errors have, doubtless, drifted in during the course of these speculations; man has undertaken to measure the Divine plan with most imperfect data, and the illusion has been too fondly cherished of attaining final and profound results while men were scarcely in the possession of the elements of knowledge. It is for us, therefore, to enter upon our inquiries with investigation rather than theory, to test the knowledge of which tradition has put us in possession, and to advance, as we may, to the new and the unexplored.

Man is the first token that we meet, that our study of the earth must contemplate it as an organized whole, its unity consummating in him. As every individual must, in his own career, epitomize the history of the race, childhood, youth, manhood, and decrepitude, so each man mirrors in his own life the locality where he lives. Whether dwelling in the North or in the South, in the East or in the West, whether the shepherd of the Tyrolese Highlands, or the Hollander of the plains, every man is, in a manner, the representative of the home that gave him birth. In the people the country finds its reflection. The effect of the district upon the nature of its inhabitants in size and figure, in color and temperament, in speech and mental characteristics, is unmistakable. Hence the almost infinite diversity in the peculiarities of culture and attainment, as well as of tendency in different nations. Anthropology and Ethnography, the science of man and of race, are the running commentaries of Geography and Topography. The historian and the geographer work toward each other,—the historian going back from the acts of men to study the scenes which have conditioned their life, the geographer going forward from the study of the habitat of men to that of their deeds. The fundamental question of history is, in fact, What relation does the country bear to the national life? What relation to the civil structure, the state?

In fact, the whole constitution of Man is thoroughly connected with the Earth on which he dwells; the roots of his being run down into it in uncounted numbers. Man receives at birth from the earth not only a spiritual but a physical dowry, from which he cannot free himself, and of whose worth he becomes conscious more and more. It is, therefore, of course one of the first of the legitimate studies to learn the limits of the realm which Man makes his home, and to

understand all its secrets, all its forces, so as to turn them to his own uses. Thus alone can he compass the sublime thought of his own freedom, the independence of his own will in the kingdom of Nature, and learn the majesty of his own spirit; for the knowledge of that freedom, which is the most noble of all God's gifts to him, is the most direct key to the attainment of that place in the present, and that destiny in the future, which God has appointed for man. Without a preliminary training, amid the conditions of a limited life, can there be no step taken toward the enjoyment of the life without limitations which is to come. Without the capacity of breaking the higher law, there is no glory in obeying it, no freedom to be valued, even in the world of thought. There can be no true speculation, no philosophy of the unlimited and eternal, without inquiry into and knowledge of the limited and conditioned. He who knows not the earthy, cannot know the heavenly; he who knows not the finite, cannot know the infinite. Statement and counter-statement are the substance to the world of thought. Pythagoras investigated matters of number and weight, before he dealt with the mysteries of metaphysical speculation. Plato thought on the human soul, and the practical details of legislation, before he gave himself to the deepest things of Philosophy. Aristotle was a naturalist and physicist, before he became a logician and metaphysician. Kant was a mathematician and astronomer, before he dealt with the problems of transcendental science. Schelling went from natural philosophy to the study of the soul of things. If there have been evil results from this, it has not been from antedating metaphysical studies by physical, but by passing too quickly from the solid foundation-stones to the more unstable heights of the transcendental. Without these solid foundation-stones, philosophy falls, crushed by its own weight; but with this preparation, we may advance to the loftiest and yet most secure speculations.

WHAT GEOGRAPHY AS A SCIENCE HAS YET TO ACCOMPLISH.

Geography can just as little be contented with being a mere description of the Earth, and a catalogue of its divisions, as a detailed account of the objects in nature can take the place of a thorough and real natural history. The very word Geography, meaning a description of the Earth, has unfortunately been at fault, and has misled the world: to us it merely hints at the elements, the

factors of what is the true science of Geography. That science aims at nothing less than to embrace the most complete and the most cosmical view of the Earth; to sum up and organize into a beautiful unity *all* that we know of the globe. The whole body of facts revealed by past and present discovery must be marshaled into harmony, before we gain the high pinnacle of Geographical Science. The Earth, in all its parts, must be known in all its relations, before we can speak of it as the scholars of our day ought to speak of the world they inhabit.

Moreover, the Earth is to be considered in two main relations—relation, and an absolute relation; that is, we are to regard it in its connection with the greater whole, of which it forms a part of the Universe, and as a body standing alone, existing, as it were, for itself. It is the latter view which falls within the strict province of Geography. The very prominence of the old Greek word *gē* indicates the pre-eminence which, in this science, our own planet rather than others, receives. *Ge*-ography confines our attention to the Earth, and concentrates it upon the globe, regarded *per se* rather than in its relations to the Universe. Taken, therefore, strictly, as already hinted at in the foregoing remark, Geography is the department of science that deals with the globe in all its features, phenomena, and relations, as an independent unit, and shows the connection of this unified whole with man and with man's Creator. Should we go beyond this, and discuss the relations of the Earth to the Universe, (as is often done in our geographic treatises, in a singularly imperfect and unfruitful manner,) we should outrun the strict bounds of a single science, and should be encroaching on the domain of the sister science of astronomy. That we have no right to do. Yet, from time to time, we must borrow the results of other departments of learning to confirm our own. The field which we have to till has been immensely reduced in its proportions by the publication of "Kosmos," which great work has almost exhausted the subject of the earth in its external relations. The limiting of our own department may, perhaps, give more opportunity for thorough investigation within itself.

The Earth, if discussed exhaustorily, must be spoken of in its relations to Time as well as to Space. The word by which we characterize it, in this regard, is History. The duration of the Earth outruns all measurement. By thinking of its beginning,

the only way we have of gaining a conception of Time. We cannot conceive of the universe as antedating the creation of our earth. By this indefinite, not to say infinite, duration of time, the Earth is discriminated from all that it contains; it is older than any of its parts; it antedates all its kingdoms. The nature of the whole is, therefore, radically different from that of any of its divisions. The Earth has had a development of its own; hence the too common error of treating it as passive and inorganic. The history of the Earth displays, in all the monuments of the past, that it has been subjected in every feature, in every division of itself, to ceaseless transformation, in order to show that, as a whole, it is capable of that organic development on which I lay so much stress. The natural powers which the earth includes are constantly obedient to the mechanical laws of chemistry and physics. The animate creation, plants, animals, man, come and go, in accordance with the laws of their being, and as subordinate dependents on the great forces which the earth holds locked up within her bosom. The earth, the mother of them all, has her own special advance, her own development, to use that overburdened German word. She has relations to herself alone; not simply to organized forms, plants, and animals; just as little to organic things; not simply to her own countries, her rocks, and her crystals. These are but isolated parts; or, if not isolated, yet bound *together* by a common tie. There is another tie above this; it is that which binds the earth to itself alone; that subordinates its parts to such an extent that they almost disappear. There is, above all this thought of parts, of features, of phenomena, the conception of the Earth as a whole, existing in itself, and for itself, an organic thing, advancing by growth, and becoming more and more perfect and beautiful. Without trying to impose on you anything vague and transcendental, I wish to lead you to view the globe as almost a living thing,—not a crystal, assuming new grace by virtue of an external law,—but a world, taking on grandeur and worth, by virtue of an inward necessity. The individuality of the earth must be the watchword of re-created Geography. To think of the Earth, as a seed sown from the hand of God himself on the great fields of space, and filled with a germinant power of life, which will transform it more and more, and make it more and more worthy of its noblest inhabitant, is the first, as it is the last, idea which we must take and keep in these inquiries.

Formerly, Geography was regarded as a mere auxiliary of History, Politics, Military Science, Natural History, the Industrial Arts, and Commerce. And in truth it does reach out and teach all these departments of knowledge and action; but only in the most recent times has it assumed the place of an independent branch of study. Only through the widening of the whole circle of sciences has room been made for this.

Geography used, for the sake of commerce, to be divided into three divisions: mathematical, physical, and political. This was at the time when it was thought that the whole frame-work of the sciences was a disjointed and sundered thing; before that minor principle of unity which binds them all together was recognized as one of the noblest conceptions that the mind can cherish. In the first two of these arbitrary divisions into which Geography was severed, the relations of astronomy, mathematics, and physics were studied, and their applications to the confused phenomena of the globe investigated. Yet the most important thing of all escaped notice; students overlooked their chief task, the tracing of causation and interdependence in the phenomena, and the relation of every one to the country which supplies its conditions of being. It was not suspected that each phenomenon was one link of a great chain of phenomena, the whole revealing a comprehensive law. Men discussed porphyritic formations, basaltic columns, hot springs, and a thousand features which dot the earth, and a thousand kinds of rock which rift the surface of the globe, and treated them singly as if each was a spore and the whole combination only a sporadic group. They did not discover that in the one feature was to be found the reason of the existence of its neighbor; that all the layers of stone owe their singularities of structure to one another rather than to themselves; that each one stands in the closest connection with the upheaval of the loftiest mountains, with the formation of great volcanic islands, and, in truth, with the building up of entire continents. And, in like manner, plants were discussed as if they were obedient to no law of grouping, as if they were scattered broadcast over the earth, having no relation to zones of vegetation, to isothermal and isochimical lines; as if, in fact, there was no suspicion of any principle underlying the very existence of the whole vegetable kingdom. And so, too, with such phenomena as the Aurora Borealis; they were treated as isolated features, rather

than in their relations to the globe; the connection was not seen between the maritime discoveries of voyagers and the great system of oceanic currents, on which voyagers are so dependent; in fact, the whole influence of the world of matter on the world of mind was unexplored.

And in order to study what was called Political Geography, a vast mass of materials was converted into a stiff, ritualistic frame-work, in the effort to impose some system and imaginal completeness on it, and not in order to grasp facts and truths in their mutual relations and inward life; they were merely arranged for convenient reference and for available use in the departments of military science, politics, statistics, and history; a method which is plainly our inheritance from the Middle Ages, and which bears the marks of those days. Thus from this arbitrary arrangement, made without reference to any indwelling necessity, sprang the three groups with which we are familiar: Chronography and Topography forming the first, Ethnography and Anthropology the second, and Statistics and History the third, or Political Geography.

From these three groups our ordinary text-books compile their usual aggregate of facts, and each becomes after its own pattern a motley in miniature. They contain variable quantities of this triple mass of materials, and follow no law but the demands of the time when they see the light; they favor, like our light literature, the whim of the hour, and are political, military, or commercial, as the public may demand. A systematic exposition of geography is very seldom to be found in them. A harmony of parts, a true harmony, is very rarely attained in their pages. They are at the foundation only arbitrary and unmethodical collections of all facts which are ascertained to exist throughout the earth. They are arranged according to countries, or great natural divisions; but the relation of one great natural division to another, the mutual and immense influence of one country on another, is never mentioned. The description of Europe follows in them to-day the same order in which Strabo set the pattern. The facts are arranged as the pieces of a counterpane, as if every one existed in itself and for itself, and had no connections with others. The setting out of these facts follows the rubrical method of grouping, according to boundary, soil, mountains, rivers, products, and cities. The beginning is usually made with *boundaries* which are generally most unstable and uncer-

tain, instead of being made with some rudimental fact around which all others arrange themselves as a center.

If we compare these geographical treatises with those made in the interest of any other great department, we shall speedily discover that they indicate knowledge rather than science; they form a mere aggregation and index of rich materials, a lexicon rather than a true text-book. And therefore ensues, despite the undenied interest of the subject and its high claims, the mechanical and unfruitful method only too common—the crowding of the memory without judgment, without thought; thence comes it that Geography has taken so low a place among our school studies, worthy only of the youngest of the pupils, and presenting little stimulus even to them.

It will be my effort, in the course of these lectures, to exhibit the subject of relations rather than to detain you with descriptions; in one word, to generalize rather than to add new details. In the lack of a thoroughly excellent text-book of geography, I shall presuppose an acquaintance on your part with the materials, so to speak, of which the science is to be constructed.

It has been a customary method to treat geography in connection with epochs of time; dealing with it as it was in the past and as it is in the present. We hear of Ancient Geography, the Geography of the Middle Ages, and Modern Geography. In this course of lectures, it will be treated not as the property of one age or another, but rather as a growth of all time, from Herodotus down to our day. It is only in this way that we can ascertain what is permanent and what is ephemeral; only in this way can we subject geography to that comparative method which has given such an impetus to the advancement of the sister sciences of Natural History; only in this way can we see how the present is the birthright of the past. Archæology, ethnography, and civil science are all gainers by this method of treatment; in one word, the whole domain of cotemporary study. The less positive knowledge we possess of the formative processes of science, the more crude our hypotheses, the more flagrant our errors. This is constantly verified under our eyes; the errors of the past are the wisdom of the present, and the gradual upheavals of our knowledge become indices, not less of outgrown untruths than of truths yet to be revealed.

SOURCES OF GEOGRAPHICAL SCIENCE.

The sources of geography, as of history, are twofold—established memorials and continued investigations. The study of it has this great advantage at the outset, that the surface of the earth is a standing monument of the past. We are obliged to search where all lies open; where investigation must be crowned with success. No manuscripts in this great library have perished; they all exist as legible, as accessible as ever. Moreover, personal investigation must be made by every student in order to understand the results of the investigations of others. Wherever our home is, there lie all the materials which we need for the study of the entire globe. Humboldt hints at this when he says in his *Kosmos*: “Every little nook and shaded corner is but a reflection of the whole of Nature.” The roaring mountain brook is the type of the thundering cataract; the geological formations of a single little island, suggest the broken coast lines of a continent; the study of the boulders which are so thickly scattered in token of a great primeval deluge from the north, reveals the structure of whole mountain chains. The digging of every well may contribute to our knowledge of the earth’s crust; the excavations made in the building of railroads may, without the loss of time, labor, and expense, be a ceaseless source of instruction. In the structure of a spear of grass, of a rush, of a single monocotyledon, may be studied in miniature the palm-tree, prince of the tropics; in the mosses and lichens on our walls, the stunted growths of mountain tops may be investigated. A small range of hills may be taken as the type of the loftiest Cordillera. The eye may be easily trained to see all the greater in the less. The study of our own district is the true key to the understanding of the forms and the phenomena of foreign lands. Whoever has wandered through the valleys and woods, and over the hills and mountains of his own State, will be the one capable of following a Herodotus in his wanderings over the globe. He, and he alone, will be able, with true appreciation, to accompany travelers through all foreign lands. The very first step in a knowledge of geography is to know thoroughly the district where we live.

Unfortunately the text-books which we now possess do not discuss, with any approach to exhaustiveness, the districts where their

readers live; and hence they cannot give any true inductive generalization of the large and the remote. In ancient times, the study of geography began with the world of nature, not with the world of books. Herodotus, being 444 years B. C., became, by virtue of his investigations on his wanderings, the first critical geographer of the Greeks. Polybius traveled through the Alps and Pyrenees, Gaul and Spain, to be able to write the history of Hannibal's campaigns. He explored the Black Sea and Egypt, in quest of facts. He is the father of all military geography; the greatest strategists have busied themselves with writing commentaries on Polybius. Strabo, the most industrious geographer of his age, did not write till he had traveled from the Caucasus to the Rhone, and from the Alps to Ethiopia.

Philip Cluver, of Dantzic, who died in 1623, the true founder of classical geography, collected, by personal investigations, the materials of his great work on Germany, Italy, and ancient Sicily, all of which countries he traversed thoroughly, the classic authors in his hand.

Alexander von Humboldt has become, by his thorough studies of nature in Europe, Asia, and America, the founder of Comparative Geography. He was thoroughly acquainted with every geographical form in the neighborhood of his home, before he traveled into foreign lands. These examples show that personal investigation is one of the most reliable of all sources of geographical knowledge.

The second class of these sources is the accounts given in the published memoirs of travelers. In more primitive days than these, when very little was known regarding the earth, personal examination was easily completed, with a good degree of fullness, by almost any tourist. With the advance of knowledge, the narratives of travelers have increased, and the sum total of facts observed has become unwieldy; and, where facts have been wanting, the imagination has amply supplied their place. Of course, a single life soon became too short for the personal examination of every quarter of the globe; the narratives of those who had thoroughly explored any one were accepted as authoritative, and these accounts soon became the most generally available of all the sources of geographical knowledge. Yet, with this limitation, that now their

abundance and their exactness tend to repress and almost to destroy any personal inquiry whatever. Nothing can take the place of some exploration and investigation on the part of the student of geography.

To the accounts of scientific travelers, may be added those maps and globes which indicate the contour and the vertical elevations and depressions of the earth or its divisions. The demand for perfect accuracy in these is now very great. The map must be a portrait, not a caricature. In its way, the map has a certain dictatorial authority; it is so decisive in its very character, that errors in it are far more dangerous than in the letter-press of books. The English excel in the beauty of their maps: there are none in the world engraved with the rare excellence of theirs; but their care to secure accuracy is not commensurate. The French and the Germans vie for the honor of perfectly transcribing nature.

THE SCIENCES ILLUSTRATIVE OF GEOGRAPHY.

The sciences which are called in to illustrate the thorough study of geography have largely increased in number within the past few years. They are, for the most part, the same which illustrate history; to which may be added mathematics and natural history. It is a very great mistake to suppose that all that bears upon geography can be crowded within the covers of a single book. It is commonly supposed that geography is a matter of memory. Even in its elementary forms, it is capable of a constructive treatment. Many a teacher, who has not paid special attention to this department, dreams that he can qualify himself by running through a single text-book. No philologist would dream that, with a grammar and dictionary, he could grasp any constructive theory of language. There must first be the study, comparatively, of the great classes. And in geography, the personal study of the earth, with critical closeness, and in the comparative method, is the true way.

Another very common error is, that geography must subsidize what is most striking in other sciences, and thereby gain its charms and attain its uses. Thus geography becomes everything—history, statistics, statecraft, physics, a catalogue of all the possessions of natural history, in all its kingdoms. It takes on all colors, and meanwhile loses its own. It merges all its individuality in other

provinces. In no way can it escape this disintegrating force, unless by holding fast to some central principle of being; and that is the relation of all the phenomena and forms of nature to the human race. It cannot exist, if it is to be merely an aggregate of all science, a mosaic of all colors. It is to use the whole circle of sciences to illustrate its own individuality, not to exhibit their peculiarities. It must make them all give a portion, not the whole, and yet must keep itself single and clear.

For the comprehension of mathematical geography, a knowledge of the elements of mathematics and astronomy is indispensable. For determining localities, and for using many needed instruments, there must be some skill in practical astronomy; for measuring distances, for projecting maps and charts, and locating geographical districts upon them, there must be some familiarity with trigonometry and the higher mathematics. No one can thoroughly study geography in foreign lands, and leave all astronomical instruments behind.

Political geography demands an acquaintance with history, and the same helps which the study of history requires. The civil status of no country can be determined without this. Büsching's "Europe" was a master-piece of its time. But it was impossible for even that book to compress within its covers the whole history of that continent in its relation to the geography of Europe.

The study of Man is, of course, in most intimate alliance with geography. It is only since the opening of this century that ethnography has become a prominent and clearly defined province of science, and enabled to become a great tributary of geography; in fact, the greatest tributary. Other departments are also drawn upon; there can be no close study of the soil, the structure of mountains and plains, without mineralogy and geology. Meteorology, too, the science which discusses the climatic conditions of countries and the effects of climate upon the organization of plants, animals, and man, is of no mean value in illustrating geography. Nor can one be a great geographer who does not understand the flora of the world. Not that he needs to be familiar with the myriads of plants, but the laws of growth and the characteristics of localization must be known. The geographer does not need to repeat in detail where the cereals and the palm-tree thrive. The general conditions which

control the growth of plants are all that he has to concern himself with. The main auxiliary for this is furnished in the botanical garden, where the eye sees the products of all localities, arranged, according to their grouping, in the countries where they are indigenous. Botany and zoology and mineralogy are among the sciences most valuable in throwing light upon geography; they display best what wealth each country holds in store for the uses of man; for they are closely connected with the development of industry, the arts, and trade.

This brings us to the last province, commerce, the science of interchange. The study of minerals, of the distribution of plants and animals, is of little advantage, aside from commerce and its uses to man. It is the interchange of the products of one region for those of another which has had, on the whole, the greatest influence on the human race. Think, for an instant, of the transfer of the potato from America to Europe, of maize to Asia; of the far more ancient introduction of wheat and rice from Asia into Europe; and not these alone, but almost all the fruits. Think of the carrying from Asia to America, and, in fact, to all tropical lands, such products as sugar, coffee, and cotton. Think, too, of the results of the search for gold, ivory, and slaves in the interior of Africa, and of gold in California and Australia, opening such immense districts to settlements. The search after platina has disclosed the most guarded recesses of the Cordilleras and the Ural chain; while the need of copper first gave us our complete knowledge of the great system of American lakes. Without the expeditions to secure the whale, the walrus, and the seal, as well as the fur-bearing animals, the polar world would be still untraversed. The discovery of coal on a hundred shores otherwise unknown, led to the settlement of man in colonies from India and China southward to the Antarctic Continent, and northward to Nova Zembla, Spitzbergen, and Greenland.

And not the continents only, seas and oceans have been thoroughly studied, in order to secure a safe pathway for man to the regions which contain his spoils. In the furtherance of this, the highest praise must be awarded to the British government. Through its enterprise and liberality, almost every island group has been examined, a thorough study of marine currents undertaken, careful soundings made in all waters, and a most extensive cartography

accomplished. The charts published by the English admiralty already are counted by thousands.

Yet the French have not been backward in like investigations. Understanding the value of commerce, their Dépôt de la Marine has not been inactive. Scandinavia has also done her part. The United States has accomplished one of the most thorough coast surveys ever undertaken by any nation; its difficulties are only to be measured by its extent. In fact, the whole civilized world has sent its messengers to the ends of the earth, and have united in this grand crusade of our age, the enriching of all men by a liberal system of interchange of the commodities of all climes.

COMPARATIVE GEOGRAPHY.

PART I.

THE SURFACE OF THE EARTH CONSIDERED IN ITS MOST GENERAL RELATIONS.

The Spheroidal Form of the Earth.

THE measurements of, and investigations into the figure of the earth, have led, as already stated in the introduction, to no absolutely certain conclusion; yet they have made it certain that the earth is, in a general sense, a spheroid. There are many discrepancies, as were then stated, from the perfectly spheroidal shape; still it is in this sense a spheroid, that the polar diameter is not of the same length with the equatorial diameter.

The globular form of the earth, using that word in a loose sense, has been established with certainty since Newton's time. The experience of circumnavigators, the uniform shield-shape of the shadow of the earth during eclipses of the moon, are witnesses to this. The gradual emerging and disappearance of objects, such as ships on the sea, in coming and going, caravans on the desert, of mountains as they are approached, establish the fact. These proofs are so well known that we but touch on them and pass to what is not so obvious.

As soon as the fact was established that the earth was a subordinate member of a system, it was brought into analogy with other planets, and their uniformly spherical shape was considered another valid reason for attributing the same to our globe. The discovery of the rotation of the earth on its axis was still another argument in the same direction. Mathematical measurements and observations of the pendulum, taken at different stations, have confirmed the same result.

To measure a spherical body, it is only necessary to take the length of a degree in one of its great circles, and to multiply its length by 360, the number of degrees. The method of measuring a degree on the earth's surface is by taking two stars, just one degree apart, dropping, by astronomical and mathematical means, vertical lines upon the earth from them and measuring the distances apart of the points where those lines impinge upon the globe. This can be done with perfect accuracy. Such investigations show that the degrees are not all of equal length, as they would be were the earth a perfect sphere. Nearer the poles they are longer, nearer the equator they are shorter. The curvature of the earth is therefore greater as you approach the equatorial line, and less as you recede from it. In general terms, then, the earth is an oblate spheroid, as it would be a prolate spheroid were the lengths of its diameters reversed. By the most accurate measurements, those of the astronomer Bessel, if the equatorial diameter were divided into 289 equal parts, the polar diameter would measure 288 of them, being $\frac{1}{289}$ shorter.

To this must be added what was said in the introduction, that the surprising accuracy of modern instruments and modern investigations, applied to meridian circles and parallels of latitude, have determined the fact that the

spheroid is not a perfect one, (just as so often in nature the ideal is rather striven after than attained,) but an irregular polyhedron of an indeterminate number of sides. Still for all practical purposes, these minute inquiries have no value, and it is enough to treat of the earth as a perfect globe, so far, at least, as map-drawing is concerned. The deviation from a perfectly spherical shape is so inconsiderable that in an artificial globe of eighteen inches diameter it would hardly amount to the thickness of a sheet of paper; still, small as this is represented on a miniature scale, it has, doubtless, great importance on the great scale of a world like this, both in affecting somewhat the perturbation of other heavenly bodies which depend on the earth, as well as the perturbations in the earth's own motion. Besides this, which is really not a small point in consideration of the possible results which the minutest perturbation of one little planet may have on the universe, there is one other, more appreciable in its results, the probable influence of this spheroidal, or rather polyhedrous form, in producing the unequal division of land and water upon the surface of the earth. The apparent want of any principle or reason for this inequality has long perplexed geographers, and there seems to be no more satisfactory solution than the one to which I have just alluded. In the course of future investigations into the yet undetermined exact mathematical form of the earth, the law which controls the division into land and water will be more thoroughly understood. Unquestionably the position of the great oceans depends upon their distance from the center of the globe, and although the present proportion of land and water seems fortuitous, undoubtedly it has a uniformly acting, and a thoroughly appreciable law.

The Threefold Covering of the Earth.

What may in the largest and most general sense be called the superficies of the earth, is threefold in character, and yet one in function; consisting of a highly elastic body, the atmosphere, water, and the solid ground. These three forms are variously proportioned; the more elastic is universal, the fluid form is more restricted, and the solid one prevails still less. The more dense the body, the nearer it is found to the center of the earth. The lightest of all floats over the entire periphery of the globe like a graceful mantle of cloud. Man, and in fact all organisms, live by contact with all three of these forms. The investigation of the elements, and phenomena of the air, *regarded in themselves*, is the province of meteorology. The mercury-column is the true language of the atmosphere, and tells us in distinct tones of all the changes there. Mineralogy and geology make us acquainted with all the qualities and all the elements of the soil, not in their relation to man, but regarded in themselves. Geography deals with the conflict of all these bodies, their relations to each other, their mutual action and reaction. Meteorology gives occasion for the study of climate, and for the observation of the phenomena of the lower strata of the atmosphere,—the fall of rain and snow, for example. Geology and mineralogy give rise to the study of plains and mountain formations, as well as of volcanic phenomena, affecting the surface of the earth as they do in earthquakes, upheavals of whole districts, and the opening of hot springs. Thus, geography has its own province clearly defined, and uses all this and studies it in relation to the organic world, and to man foremost of all.

The most highly elastic covering of the earth is un-

broken, the other two are sundered, and each only occupies a part of the surface. Formerly, in most ancient times, the water seems to have covered the entire earth. The study of this is, however, within the domain of geology. We have to do only with the historic period which followed. We have to look at the earth in its present relations, and as the home of man. Now, the portions covered with water are, by far, the largest part of the surface; a little less than three-fourths are water, a little more than one-fourth land. The whole water-mass is composed largely of the oceans, which, in one sense, constitute a continent of their own: in looking at them as we do now, we are not to regard them as ceasing at the outlines of the great land-masses, but as penetrating these as far as to the springs which feed the rivers; for the world of waters, embracing springs, brooks, rivers, lakes, seas, and oceans, is one, and but one.

The water is, in some respects, a form between the other two; its peculiarities, weight, density, freedom of movement, and changeableness of form, are a mean between the opposing extremes of air and the ground. Water can pass to a more fluid or a more solid state; it can become vapor or ice. The measurement of the depth of the world of waters has lately been so clearly connected with the needs of civilization, that geographers have made many exceedingly accurate investigations. Formerly, this was much neglected; up to Captain Cook's time 1500 feet was the greatest depth ascertained; in the course of the Arctic discoveries 7000 feet limited the plummet's descent; Captain Ross sounded, near St. Helena, to a depth of 30,000 feet; and Captain Denhorn, in the South Atlantic, reached a point 40,000 feet from the surface—about twice the height of the loftiest mountains. And not single points

alone, but entire ocean districts have been traversed; the temperature of these great depths has been studied, the currents, the density, in fact all the features which must be known preliminarily to the laying of great lines of submarine telegraphs, such, for example, as that proposed between North America and Europe.

The atmosphere, too, is by no means thoroughly known to us. It rises to a height between 85 and 95 miles from the earth, of which man has explored in balloons only about five miles, or the height of the loftiest mountains. At loftier heights than we can live, the bright light of mid-day even fades into a dim kind of twilight, and meteoric masses of iron are seen in full glow, there being oxygen enough even there to support their combustion, and very little resistance to overcome from the density of the atmosphere. Astronomers, Benzenberg in particular, have calculated the distance of the meteors to range from 23 to 100 miles from the earth, and have studied them* in respect to the time when they were visible, their locality, and their direction. The limits of the atmosphere must be at that point where the expansive power of air and the attractive influence of the globe neutralize each other. The form of the atmospheric body is therefore, like the earth, spheroidal, but far more oblate than the earth, in consequence of its much greater fluidity. At the poles, the distance is therefore much less from the surface of the earth to the confines of the atmosphere than at the equa-

* Meteors, which are nightly visible, are different from the periodic phenomena, seen in August and November, in different localities over the earth, and called falling stars. These exist outside of our atmosphere, and belong not to the earth, but rather to the great solar system.

tor. The effect of this upon the refraction of light must be very great.

The investigation of the interior of the earth is more difficult to us than that of the atmosphere even. We cannot say that we *know* thoroughly more than we can learn by penetrating $\frac{1}{8000}$ part of the distance to the center of the globe. Deeper than that our lowest shafts have not sunk. The coal mines of England penetrate perhaps the farthest below the sea level; for the deep mines in Germany, in the Hartz district, for instance, have their entrance hundreds of feet above it. One coal mine near Durham, England, descends to a depth of about 1584 feet, and reaches a point where the thermometer is 79° Fahrenheit. The deep coal mines of England have, however, one rival, in a shaft at Liege, which is sunk 1800 feet.

The modern Artesian well has gone to still greater depths, in the effort to procure brine for the manufacture of salt, or fresh water for the use of cities. At Rehme, in Porta Westphalica, a point 2160 feet from the surface has been reached, and water brought up at a temperature of 90° Fahrenheit, containing four per cent. of salt. By an ingenious application of mechanics to the process of well boring, doubtless a depth of 5000 feet could be attained. At Mondorf, in Luxemburg, a bore has been made through sandstone and the mineral formations lying beneath it, for a distance of 2700 feet, and water reached at 82° Fahrenheit.

The great upheavals caused by earthquakes and volcanoes disclose still vaster depths. In the eruptions of the latter, immense masses of the inner contents of the earth are thrown out, sometimes enough to form a not insignificant mountain, and to desolate large regions with their debris. As a general thing, the original mineral forms are

lost and indistinguishable in the molten mass. Yet not seldom perfect specimens are hurled out, imbedded in lava and cinders; not always minute fragments, sometimes huge blocks, testifying not with any degree of completeness, yet clearly, to a certain extent, of the composition of the region bordering on the great inner sea of molten matter. Yet most of our knowledge upon this subject is hypothetical, and what we know only indicates painfully the great extent of that of which we are entirely ignorant.

The uniform increase of temperature, as we descend into the earth, at the rate of about 24° Fahrenheit for every 100 feet, the heat of some mineral springs, leads to the conclusion that, could we advance to a place about twenty-three miles from the surface, we should attain the limits where all becomes a molten mass. The cold surface, on which we walk in such security, seems, by all analogies, to envelop a liquid caldron which has been seething from the morning of the world. This internal mass is, of course, the source of all volcanic eruptions, and of all the phenomena to which I have alluded above. A distinguished geologist has well said that "light and heat are the two extremes of being: the farther man goes away from the earth's surface, he encounters light; the farther he recedes inwardly from its surface, he encounters heat." It is true we are not absolutely certain that the rate of increase is uniform, at the rate of one degree Fahrenheit for every 45 feet; but if it is, we should reach the boiling point of water at less than 10,000 feet from the surface, and the melting point of iron (22° Fahrenheit) a little over 120,000 feet. The relation of this thickness to the entire diameter of the earth is about as 1 to 344, about the ratio of the thickness of an egg-shell to the egg.

The Superficial Dimensions of the Land and Water on the Globe.

The equatorial diameter of the earth, 7925·6 miles, multiplied into the circumference, 24898·8, equals 197,339,590, the number of square miles on the earth's surface, reckoning as if of a true sphere. The deduction to be made, in consequence of its spheroidal shape, has not yet been estimated with any approach to nicety. The sum indicated above is exact enough to satisfy geographical purposes; enough to lead to the laws of relative rather than to a minute individualization. The proportion even of land to water has not been determined, except with approximate accuracy. It has been commonly stated that two-thirds are water and one-third land; others have computed three-fifths to be water and two-fifths land. The most accurate measurements, those instituted by Humboldt, have left it in this statement, that if the whole be taken as one, the sea occupies ·734, the land ·265, or, reduced and simplified in almost unchanged form, a little more than three-quarters water, a little less than one-quarter land. Of course it is impossible, as yet, to attain to accuracy in these estimates, as our knowledge is imperfect regarding the polar regions; there are about 17,000,000 square miles unexplored.

The ascertaining of superficial areas with exactness is one of the most costly operations undertaken in the interest of science. The first mathematical survey of France, one hundred and fifty years ago, undertaken by Cassini, cost four millions; the second sixteen millions; a third, still more costly, has been made within the present century. Still, it must be said that few countries have expended money in this direction with as much prodigality as

France. In Turkey, for instance, so little accuracy has been attained, that the survey of that country, undertaken by Beauchamp early in this century, resulted in establishing the Sultan in possession of 17,000 square miles which he had supposed were covered by the Black Sea. The recent surveys of Prussia have rectified similar mistakes, and, in the constantly increasing accuracy, have given hundreds of square miles to the Crown. Many countries, and in truth the most, have never been subjected to a strict mensuration. The jagged coast lines of islands and continents have been so great a barrier, that we have to speak with great uncertainty of the superficial contents which they inclose. The statements of these make no pretense, therefore, to accuracy. We must be content, at present, with the rudest approximation. This accounts for the discrepancy in our geographical compendia; no two of them agree, unless one servilely copies the other. The statistics relating to the superficial contents of continents, and of separate countries, must be taken with a great deal of allowance. The evil cannot be remedied at present; it will be, doubtless, at some future day. The discrepancies which it occasions will be seen, from the fact that the area of Europe has been computed to be between 3,254,800 and 3,870,500 square miles; that of Asia between 16,180,000 and 16,831,600; that of Africa between 11,257,200 and 11,513,600; that of America between 12,140,400 and 15,963,600; that of Australia between 2,756,000 and 3,201,200 square miles.

According to this, Asia is five times as large as Europe, and almost six times as large as the continent of Australia. Africa is three times as large as Europe. America is four times as large as Europe, and is as large as Africa and Australia combined. Europe would make about one-third

of Africa, one-quarter of America, one-fifth of Asia. Our present knowledge does not allow us to speak more definitely nor exactly.

Contrast of the Land and Water Hemispheres.

Whether we divide the globe into northern and southern or eastern and western hemispheres, their relative amounts of land and water will be different. The northern hemisphere contains (speaking approximatively as above) 38,541,600 square miles of land, and 59,619,700 of water; the southern, 12,847,200 of land, and 85,526,100 of water. The eastern hemisphere contains 36,760,800 square miles of land, and 61,401,000 of water; the western, 14,628,000 of land, and 83,533,300 of water.

Besides the division quantitatively, the division in respect to symmetry of shape is entirely irregular. Symmetry, as we usually use the word, consists in the arrangement of parts at equal distances, or two sides at least, from some central point or line. Mineral crystals are regarded in relation to the point where crystallization began; plants are viewed in relation to the stem-axis; animals in relation to the symmetry of the entire structure. A similar law of symmetry is entirely wanting to the globe; its arrangement is altogether unlike this; it is not nearly so perceptible at first glance, yet it is far more profound in design and comprehensive in its relations.

The land is broken up into masses, varying in size, and called, arbitrarily, continents and islands. Strictly speaking, there are but two continents, the old world forming one, the new world the other. Australia may be called the smallest continent or the largest island; it is the connecting link between the forms, and shows at a glance the arbitrary distinction. We might easily go further and call

New Guinea, Borneo, Sumatra, Great Britain, and Java, continents, and, on the other hand, we might designate the old and the new world as islands. There is nothing absolute here but the usage of speech.

The continents and islands lie mainly in the northern hemisphere, (38,341,600 square miles,) scarcely a third part of their superficies (12,847,200 square miles) being in the southern.

The continents are so situated also that the eastern contains by far the largest body of land, (36,760,800 square miles,) the western being only about one-third as large, (13,628,000 square miles.) America, the western, it will be seen, has no first-class island lying near it; it stands isolated.

It is seen by this that the greatest mass of land lies in the northern hemisphere, dividing the earth in one way, and in the eastern dividing it in another; the smallest mass in the southern and the western. In the northeast the watery realm is the most contracted, in the southwest the least. We are thus enabled to speak of the land side of the globe, the land hemisphere, and a water side, the water hemisphere.

The central point of the water hemisphere is at the island of New Zealand. Toward this the points of all the continents are directed. The center of the land hemisphere is in the northwest of Europe, at a point near southeast of England, the northeast of France, and the coast of Holland. The dwellers around the North Sea are the antipodes of the New Zealanders. Great Britain is the country which, as a whole, is the middle point of the continental world. In the oceanic world, the islands lie like scattered dots, insignificant in respect to area, in comparison with the waste of waters which surrounds them, while,

on the other hand, the land hemisphere is so solidly compacted, that even the Arctic Ocean becomes merely a broad channel.

Thus arises the first great contrast which we have to study: the first, and next to the great primary distinction between the North and South, the most important. The division into land and water, aside from commerce, must exercise the strongest influence on the distribution of heat and cold, affecting the temperature of all the zones. This influence has been fully noticed and brought before the world by Alexander von Humboldt. It is sufficient to refer to it now as a well-determined fact in physical geography.

The heat equator is a little farther north than the mathematical equator, because the land hemisphere has a greater heat capacity (if we may use an awkward but apt word) than the water hemisphere. All other isothermal lines are modified in their greater or less coincidence with the parallels of latitude as they advance from the heat equator toward the maximum of the land hemisphere, or, in general terms, as they go northward. In the western hemisphere the isothermal lines follow much more exactly the parallels of latitude than in the eastern, which is pre-eminently the land hemisphere. In America the proximity of immense masses of water causes a perceptible reduction of the heat from that of the eastern where the land form prevails. And the heat diminishes more as we advance toward the South Pole, than toward the North, in consequence of the greater deficiency of land in the southern hemisphere; while in Lapland, Greenland, and in Siberia, even within the polar circle itself, men find sustenance, and trees live, in the same latitude, at the South Pole, no vegetable life, worth mentioning, is found. The frigid

zone and the temperate zone of the southern hemisphere are not coincident with those of the northern. The icebergs which are formed at the South Pole are carried much nearer to the equator than those found at the North Pole.

An important phenomenon, first pointed out by A. von Humboldt and Dove, is closely connected with what has just been said. The Atlantic shores of the old world are warmer than those in the same latitude of the new world. Norway, England, and France are warmer than Labrador and Canada; Spain, Portugal, and Morocco are warmer than Florida; Congo and Benguela are warmer than Brazil, although the countries brought in contrast all lie on the same parallel.

A similar analogy is drawn from the west shore of America: Northern California is warmer than Japan and Corea, which are in the same latitude. It is true, other factors are at work to produce this, such as winds, marine currents, elevations of land, etc., of which more will be said hereafter.

Both of the two great land divisions of the earth, it will thus be seen, have their peculiarities. But there is a great equalizer of their diversities, found in a great coast-belt, of which I must briefly speak. It passes from the Cape of Good Hope northeasterly at an angle of 45° , passing through the Mozambique channel, thence skirting the entire southeastern and eastern coast of Asia, taking in China, Corea, Japan, and South Kamtskatka; thence it turns southward, following the whole western shore of America to Cape Horn. This belt is broken at only two points—a brief break at the north, at Behring's Straits, and a large one between Cape Horn and the Cape of Good Hope; in other words, at the points nearest to the North

and the South Poles respectively. This coast belt has a relation to the habitable world similar to that held by the temperate zone as a mediator between the torrid and the frigid. It partakes of the character of the sea and the land, and shows the advantages of both. It does not run parallel with the lines of latitude, but crosses them diagonally, in the same direction with the ecliptic, though at a more acute angle. This belt moderates all extremes. Coincident with it are the paths of the sea and land winds, the course of the monsoons, the most fertile shores of the whole globe. It divides the surface of the globe into three great divisions, the two great bodies of water, and the great, and, comparatively speaking, unbroken (for the break at Behring's Straits is of little importance) land-mass. On the great coast line referred to above is the center of the great natural acclivities of the globe. It is the most varied, the most stimulating, and the most productive in all departments of the vegetable and animal kingdoms. The Atlantic coast belt, which also has great influence on the eastern districts of the new world and the western districts of the old, crosses the great coast belt at almost right angles at the place of its great sundering between Cape Horn and the Cape of Good Hope.

If the contrast between the sea and the land has the effect indicated above on the general development of organic life, it must of course have great effect also on the life and character of man. Man eminently depends upon the conditions amid which his lot is cast. The inhabitant of one of the Pacific islands dwelt in a world whose utmost possibilities to him lay in the adjacent islands within view, and which his canoe could reach in a few hours' sail. The difference in culture between him and those whose range of observation has been greater, must be immense.

The compacted land division of the globe, the solid cluster of continents, must be the source of stimulus and culture, of which the isolated inhabitant of the Pacific islands knew nothing, till commerce had at length linked the world together. Only with the improvements in navigation could civilization reach him. The European had to carry his culture to the New Zealander, his antipode.

The ancients had little suspicion of all this. Yet the contrast between the land world and the water world did not escape Strabo's keen glances, and he hints at its effects on man. It is glanced at in one passage of his 15th Book. He is speaking of the effect of the moist air of India in contrast with the dry air of Libya, and shows that he appreciates that these are not without their influence on the constitution of the Indian and of the Ethiopian. "Some," he says, "rightly ascribe it to the sun, that, in the absence of moisture in their air, the rays burn so deeply into the body of the African; the Indian, on the other hand, is not jet black and curly-haired, because, in his country, he enjoys the moisture in the atmosphere."

The Position of the Continents and its Influence on the Course of History.

Besides the three great forms spoken of above—the compacted land-mass, the great water-mass, and the subordinate water-mass—the position of the continents leads us to another discovery of prime importance.

The question arises, What relation have the continents, taken separately, to the entire mass which they constitute? What relation do they bear to each other? What influence does the proximity of great land forms exercise? What influence their remoteness from each other? Is the arrangement of the continents fortuitous, or adapted to

great ends always held in view by the Creator? Has Nature been left in this to a wild, passionate caprice, or has she been subjected to law, and been compelled to subserve the interests of humanity? And is it not worthy of study, worthy of science, to investigate these things, to master their law, and observe here the workings of the Divine Mind?

In the solar system, we have for a long time minutely studied matters of size and distance, the approach and receding of planets, and observed the effects of all these things with an accuracy which could not be too thorough. In the study of our Earth, this has been neglected, because heretofore those great tracts of land and water have seemed of little mutual influence; because they are fixed forms. Yet they have a greater influence, perhaps, on this very account. Although there is in them no law of gravitation to study, yet there is in them the display of forces no less surprising than those of attraction, and which are to be read in the light, not of mathematics, but in the light of history. It indeed seems self-evident that a grouping of these great forms cannot be without an influence on the progression or retarded development of nations; on the amount of population, the progress of colonization, and the union of States in offensive and defensive alliance. Should a higher Power throw the continents out of their present position and relation to each other, a new history of the world would date from this day.

Here, then, is the primary element of history; the laws of continental arrangement are the starting-point. Mathematics has thrown a net-work of meridians and parallels over the surface of the globe; but these lines exercise little influence over the course of history. The symmetry and regularity which they suggest do not belong to the earth;

the earth is not bounded, like a crystal, by right lines. There is a freer play than that mathematical mark of parallels and meridians suggests; there is an interdependence of the great land districts of the globe that these regular lines do not indicate; a higher law of order, evolving the most perfect results from elements seemingly the most discordant.

The Pyramidal Forms of the Great Land-masses, and their Southward Direction toward the Oceanic Hemisphere.

The great land-mass of the globe accumulates in size as we advance toward the North Pole. South of 55° S. lat., the continental form disappears, and the tracts discovered of late years in the neighborhood of the South Pole are apparently islands, or rather long ice-coasts, whose continental form is very doubtful. The great land division, embracing both the old and the new worlds, reaches to about 80° N. lat., and the extreme points come even yet nearer to the Pole. The distances of one body from another, as, for instance, from Greenland to Iceland, are very small, in comparison with the immense spaces which divide the southern points of the continent, where the hundreds of miles of separation at the north expand into thousands. Expansion of the land-mass is the law at the north, contraction at the south. The great land formations terminate in wedge-shaped extremities, a fact observed by Lord Bacon, J. R. Forster, and Steffens; America ending at Cape Horn, 55° S. lat. Australia, which may be considered to embrace Tasmania or Van Diemen's Land, at the southern extremity of the latter, 45° , and Africa, at the Cape of Good Hope, 35° S. lat., respectively. Humboldt gave the name of "Pyra-

midal Structure" to this cone-shaped form of the great land-mass, which, it will be observed, all are directed toward the south. This pyramidal structure contributes very much, unquestionably, to the diminished heat of the southern hemisphere, and has given a great predominance to the population of the northern in comparison with the southern; and not in respect to number alone, but also to mental and moral force of character.

But not the southern extremities alone of the continents exhibit this wedge-like form; it is repeated also in the northern countries of Europe and Asia. In Europe we discover the working of the law in the peninsulas of Spain, Italy, Greece, the Morea, and the Crimea, and also in the great Scandinavian peninsula. The same phenomenon is repeated on a scale far more imposing in Asia, in the great countries of Arabia, India, and Farther India, Corea, and Kamtchatka; also in both halves of America. Exceptions are rare. In Great Britain, the pointed extremity is toward the north, and the greatest breadth at the south; but this is a peculiar case, and has its exceptional causes; and perhaps with reason, for this island has hitherto maintained an individual and exceptional character in the development of modern civilization.

Various explanations have been offered for the almost star-shaped figure which the combined body of great peninsulas assume, radiating, as it were, from the center of the land hemisphere. This is seen very strikingly in looking at a horizontal projection of the northern hemisphere, viewed from the North Pole. There has been evidently the working out of some great design in this, and the forces employed must have been of the first order of magnitude. Clöden attributes it to the rotation of the earth in its plastic, formative state. Link ascribes it to

electrical forces, generated at the time the earth's crust was hardening into its present consistency. J. R. Forster finds an explanation in the theory, that formerly great currents, now not existing, passed, or sought to pass, from south to north or northwest. He attributes to these the parallelism of the great gulfs which indent the coast-line of the old world, the uniform abruptness of the shores at the south, and the gradual widening of all the great land-masses as we go north. The Atlantic is a channel cleft by those great currents. Behring's Straits is a smaller one; but everywhere else the effort was incomplete, and no opening was effected, except in the straits of minor importance, which separate island from island, or from the main land. The fossils discovered by Pallas seemed to favor this theory, but later investigation has showed that they do not.

Link overthrew Forster's theory, yet the phenomenon is worthy of study. Viewed on a map of the land hemisphere, constructed according to Mercator's projection, it is a storehouse of interesting observations and studies, and is to be recommended to the student's careful attention. We must pass over the theories; scholars disagree as to the cause; Pisis ascribes it to a hidden law of geometric construction; Necker, Brewster, and Dana, to magnetism. We must simply accept the facts for the present.

A careful study of the land surface of the globe suggests interesting comparisons with what we know of the heavenly bodies, Jupiter, for example, and our moon. Unquestionably, the entirely different grouping of what seem to be the great features of that luminary must have had an influence on the whole course of history there. We will not enter into speculations regarding this, however,

referring the reader rather to the thorough investigations of Beer and Mädler.

Situation of the Continents in their Relation to Each Other and to their Collective Whole.

The relation which the continents bear to each other arises, primarily, from their position in reference to the cardinal points of the compass. This has been a principle from the earliest times, and the great laws of population may, in their working, be referred to this simple law of grouping.

Asia was known as the Orient, or, in the apt and beautiful German phrase, the *Morgenland*, or Land of the morning; Europe and the northern rim of Africa, as the Occident, or, in the German, the *Abendland*, or Land of the evening. In the south lay the torrid regions of the Ethiopians, in the chill north the country of the Hyperboreans. This fourfold division of the earth was for many centuries the only one known; the division into continents being made, according to Herodotus, by the Phenicians. And in very truth, a great principle lay in that rude and primitive division; it was in entire harmony with nature, and, up to the latest times and the opening of a new world, in entire harmony with history also. With Asia, the Orient, is connected indissolubly the development of the ancient world; with Europe, that of the modern. The contrast between these two great divisions is wonderfully analogous to that of morning and evening. The whole culture of the West had its root, its beginnings at the East. The East is not merely the place where the sun begins his daily course; it is the cradle of man, of nations, of dynasties of every sort, in politics, religion, and science. All the old royal houses came into Europe

from the East; they are all "children of the sun," no less than the princely families of India and Persia. The West merely witnesses the progress of what was begun in the East. From the most ancient times onward through the Middle Ages,—from Homer to Dante's "Purgatorio,"—the West is associated with the kingdom of the dead, with "Hades," and the "islands of the blest." And within these two great divisions of Orient and Occident are comprised smaller ones, adapted to more limited conceptions of the extent of the earth, but growing out of the same root with the larger division. Bactriana and India constituted the Orient to the inhabitants of Western Asia, Syria their Occident; Asia Minor was the Orient of the Greeks, Italy and Sicily their Hesperia; while the Romans called Spain theirs.

Between the Orient and Occident, and yet to the south of both, lay the Libya of the ancients, exposed to the sun's direct rays. In the very middle of the earth, on both sides of the equator, and not at the South Pole, is the true South. There we must seek the phenomena of the tropical world in their culminations. As high noon, the middle point in the hour, is the consummation of the day, so the torrid climes of the equatorial belt, at the very middle of the earth, afford the extremes of luxuriant growth.

The broad tracts of land at the northern polar regions formed the true physical contrast to the Orient and the Occident, as well as to the great South of central Africa. They lay around the North Pole like a vast shield of earth, unbroken except by the comparatively insignificant seas and gulfs of that region. And even where the water has broken its way and severed those northern lands, a submarine volcanic activity is, even now, constantly at work to restore the break, and bind the coasts together.

At about 70° N. lat., all the countries of the north are brought into great nearness, and that parallel is a highway of little else than land crossing the North Cape of Europe, Cape Chelagskoy, in Tchooktchee, at the northeastern extremity of Asia, and touching Cape Bathurst, and the Fury and Heckla Straits of North America. North of this highway and of the Georgian Archipelago begins the great group of circum-polar islands.

The break between Asia and North America, at Behring's Straits, is but fifty-six miles wide; it is the mere outlet of the Sea of Kamtckatka into the Arctic Ocean. The space between the northeast of America and the northwest of Europe is much greater indeed, but, in comparison with the distance between the southernmost points of the old and the new world, insignificant. The distance from northern Norway to Greenland is but about 940 miles.

It is noteworthy that, at the north of the great continental land-mass, where minor seas and channels break through, great volcanic forces are constantly at work, as hinted at above, to restore the unity. In the Sea of Kamtchatka lie the Aleutian islands, extending more than 950 miles, and forming what has been happily termed a bridge from the old world to the new. It consists of more than a hundred rocks and islands, some of which have been thrown up within the memory of man. In 1806, von Langsdorf and Tilesius witnessed the emergence of one of these, with a cone-shaped center, and about twenty miles in circumference. Grewingk has counted more than fifty volcanoes in activity within the limits of this island chain. The Curile islands, more to the south, form another similar volcanic group, extending from Japan to Kamtchatka. In this range there are known to be at least ten volcanoes, 10,000 feet in height.

The same high degree of volcanic activity must have formerly existed between Europe and America, for the traces of it are still visible. And not the traces alone, but a part of the same activity. And doubtless the shallowness of the waters between those continents hints at the same. More accurate explorations, then, will probably reveal multitudes of mountains, thrown up by these submarine forces, but not far enough to emerge and bear the name of islands. Yet many have emerged—those which fringe the shores of Norway, Scotland, and Ireland; the Orkneys, Shetland, and Hebrides islands; the Färöe group, with their blistered surface, their recesses, and volcanic rocks; Iceland, with its hot springs; and Mount Heckla; Jan Mayen, with its frightful craters, and the eastern coast of Greenland; one island, Sabrina, in the midst of the Azore group; which has had three upheavals within two hundred years, in 1638, 1723, and 1811,—all these plainly indicate the presence of tremendous forces, active in the past as well as in the present.

We thus fix the character of the arctic polar lands to be a close drawing together. Europe has, fortunately for itself, the least share in those inhospitable regions; only her pointed northern shores fringe the shores of the polar sea, leaving the great bulk of the great land-mass of the north to the broad shores of Asia and North America, with their neighboring island groups.

This polar world, as we may call it, in contradistinction to the Orient and the Occident, is not separated from more southerly regions by any great physical line of demarkation. The arctic circle is a mere mathematical line $66\frac{1}{2}^{\circ}$ N. lat.; it has no geographical character whatever. The true polar world reaches in some places far beyond this mathematical barrier, bringing all its characteristics

with it; while, on the other hand, it withdraws, at a few other places, nearer to the Pole. Were the polar world more broken up than it is by inland seas, and separated from the great land-mass by broad channels, it would be far more isolated in its whole character than it is. It is this immediate contiguity of the polar world with the great land-mass which opens it to whatever civilization it may be able to receive. And there is the same unity in the polar world that there is in the tropical world. The same phenomena which appear in one part of it are repeated in every other part. There are, of course, subordinate modifications found, but everything essential, which is discovered in one part, is discovered in every other part. There is no distinction into "new world" and no "old world;" the new world and the old coincide amid the arctic pole.

The characteristic of the polar world, next to this of unbrokenness, is the simplicity, or what might be called the monotony of its productions and all its features; the uniform reproduction of the same plants and animals, as well as of geological forms. Even Lapland, which is the farthest removed from the Pole of all the arctic regions, manifests, in its rounded and polished granite and gneiss and its deep and sharply-defined cuts, the same uniformity. The syenite found at Lake Imandra displays the same characteristics as that found on the islands in the White Sea, and on the shores of Greenland. The tops of the mountains, instead of being green, are all white with the lichen, commonly known as reindeer moss. And as with the geological formations and the vegetable kingdoms, so with the animal kingdom. Elsewhere are found bears, foxes, reindeer, seals, and walruses; the feathered tribes partake of the general monotony of structure, and man not

less. The range of his development is extremely limited, and his character little different, whether in northern Asia or northern America.

America forms the real West of the great land-mass, the true Occident of the earth, young as yet, but to receive as its gift the entire culture of the East, and to advance by giant steps to a position of independent influence. Already it has far surpassed Asia in industry and civilization. The old world was the preparation for the new. Almost everything which the new world enjoys and values was the gift of the old. Its most ancient monuments of religion, architecture, and art are closely linked to those of the old world. Hieroglyphics have been found among the Peruvians and the Mexicans. In like manner embalming of princes, the engraving of astronomical data upon rocks, were borrowed from the East.

The *historic* character of America is more striking in respect to newness than the physical features of the water hemisphere. Buffon supposed that the American continent is of more recent formation than the old world, assigning for his opinion that it is more submerged, because smaller in area, than the eastern land-mass; because, also, the plants which demand moisture are predominant over those which depend on a dry climate; and because the forms of homologous animals—the elephant, rhinoceros, crocodile, turtle, apes, and serpents, for instance—do not attain the same size as in Asia and Africa. But waiving this, we use the name New World, only with significance in its connection with history.

With the discovery of America begins a new period in the history of man and of nations in their civil relations. The enlargement of territory occasioned by it was not greater than the enlargement of the bounds of thought.

The old world had been developed earliest, had gone as far as it could go; it had to wait till another great step should be taken before it could go on in its course. The highest progress of the human race, the complete development of its possibilities, was not possible till man should, in his wanderings from east to west, compass the globe, and take possession of it, not for a day, but for all time. The primitive settlements in Mexico, Peru, and Yucatan could not sustain themselves in consequence of their isolation; navigation was in its rudest stages, and it needed to be in its highest before the world should be bound together closely enough to advance in all its parts toward the goal of a perfect civilization. Those primitive colonies perished therefore, as Canaan perished before Israel, and were replaced by others. The reason of this lay in the isolation of the land-masses of the earth. Had America been discovered and made accessible to the old world before the diffusion of the Gospel and the establishment of the Christian Church, it would have been too early, and heathenism might have had its grandest triumph and its loftiest temples in the new world. The way was not open as yet for the high moral development of the race; and the highways of civilization were not made till the most modern times, when all was in readiness for the great advance which we are witnessing now.

The contrast to the great continental hemisphere is found in Australia, a land-mass of no insignificant size, situated at the center, or very nearly at the center of the great oceanic hemisphere, and surrounded by hundreds of groups of islands, generally of quite unimportant magnitude. The name Australia was fitly chosen; it indicates its true relations to the Southern or Austral ocean. As Africa is the true South to the eastern hemisphere, Australia is the

true South to the great continental land-mass of the whole globe. As the earth has two magnetic north poles, and two north poles of cold, one of the former in Siberia, north of Lake Baikal, and east of Cape Taimura, 110° east of Greenwich; the other in the neighborhood of Melville Island, in North America, 102° west longitude from Greenwich, so there are, in a physical sense, two south poles, (we do not refer to the magnetic ones and the poles of cold,) a continental south pole in Africa, a marine or maritime south pole in Australia.

This country, the largest of islands or the smallest of continents as we may choose to designate it, the most remote of all the great divisions from the center of the land hemisphere, has been the last to feel the pulses of civilization. There, therefore, is to-day the most rapid, the most amazing advancement to be witnessed on the earth; it has crowded centuries into decades, and with its shores adorned even now, in its youth, with states and cities, it cannot longer be called a land left behind in the world's advance. It has inherited all that was finished in the knowledge and culture of the continental world; what the people of that world have toiled for years to win, becomes at once the birthright of the Australians. It is only an instance of the truth of Humboldt's remark, that the more full the world is of ideas, the more rapid is its progress—a remark which throws the strongest light upon the connection of geography with history.

The Historical Element in Geographical Science.

While so many a spot in the great continental land-mass was once the home of a high culture, and from being a cradle of arts and sciences has become a deserted waste, the civil and political condition of many people in the re-

mote districts on the oceanic side of the globe has advanced with unprecedented rapidity. The course of development has been very different from what it was formerly. Distances, natural influences, natural productions even, yield always to the victorious march of man, and disappear before his tread; or, in other words, the human race is more and more freed from the forces of nature; man is more and more disenthralled from the dominion of the earth which he inhabits. The history of specific districts and of entire continents confirms this.

The first inhabitant of the sandy valley of the Nile was a dweller in a waste, as the nomadic Arab is to-day. But the later and more cultivated Egyptians transformed that waste, through the agency of irrigation and canals, into the most fruitful garden of the world. They not only rose themselves, but raised their own country, hitherto so sterile, into a place of the first importance, and did it by the simplest of means,—the bringing the water and the land into more intimate relations. Through neglect and the tyranny of successive kings, the fruitful valley sank again into its waste condition. The district around Thebes became a desert, the fruitful Mareotis a swamp; similar phenomena occurred in many parts of Europe and Asia.

Another example of man's subjugation of nature is found in great mountain chains. During the first centuries after Christ, the cultivated south of Europe was separated from the uncultivated Celtic and Teutonic north by a great natural barrier, the unbroken, untraversed Alpine chain, which passed through all central Europe from west to east. At the south lay the rich states of the old world, beyond the Alps was the cold and barren north. But this old formidable barrier has vanished, as the thronged cantons of Switzerland and the crowded villages of the Tyrol

yearly bear witness; and they draw thousands of tourists instead of repelling them. What a mighty change! From Provence to Styria run the stately forms of the Alpine chain; but the deep recesses and the lofty highlands are thickly peopled, the forests are thinned, the obstructing rocks removed. No longer a barrier between the north and the south, as it was in the time of Julius and Augustus Cæsar, Switzerland has become a country of stupendous highways. The peaks which were once unapproachable, and around which merely eagles idly flew, are now the passes of Mount Cenis, the Simplon, Saint Gothard, the Splügen, and Saint Bernard; while the snowy heights of Ortler, in eastern Alps, now give place to a public road. Over the Semmering Alp a railway even passes. Just as the wild horse of Toorkistan has given up his freedom and has become the tame and useful servant of civilization, so this Alpine segment of the globe has changed all its relations to the adjacent countries. The influence of the most stupendous natural objects is weakened every year. The physical dimensions may and do remain unchanged, but their influence on life and on history is undermined by those new conditions which operate so powerfully in freeing man from the dominion of nature. The power of man makes him master of the earth, and gives even the key to the subjection of the grandest mountain chains into his hands.

In further illustration of this, take the Ural chain, which was and still is the eastern division line of one continent, and the western barrier of another, but which has become, since the days of Peter the Great, a grand center of labor and commerce, a great avenue of civilization in its return passage from Europe to Asia. And so everywhere, from the wild Caucasus and the Himalayas to the grand Cor-

dilleras of America, the same progress is seen; man becomes more and more the conqueror over nature. And not in mountains alone, but in the great forest regions of central Europe, in the primitive wilderness of North America, and in the marshes of the Netherlands, does man vanquish the forces which once fettered him. The once fearful wastes of Sahara have become the track of caravans; the sterile plains of Australia and California have drawn great colonies to their gold mines; the ice seas at the north have become, through the efforts of Parry, Franklin, and others, the scene of heroic exploits and of grand struggles of man with nature; indeed, the greatest victories of modern civilization have been there, and the playgrounds of polar bears and walruses have witnessed the noblest humanities, and the loftiest courage, and the most disinterested heroism of the age.

The continents and oceans have witnessed still greater transformations. The seas were once the impassable barriers of nations. The birds of the air only traversed the great distances which separated shore from shore. The metallic stores of the earth, the vegetable and animal kingdoms were not transferred to any extent from place to place; the sea brought nothing from lands remotely foreign but drift-sand, cocoa-nuts, floating wood, ice masses, and seaweed, swept by the great currents from shore to shore. But now the seas are no barriers; they do not separate the continents but bind them together, and unite the destinies of nations in the closest manner. The great improvements in ocean navigation have entirely changed the relations of the entire globe. The isolated island of St. Helena, which was for centuries at the very confines of the known world, became, within the second decade of the present century, a prison-house for the great European

robber, and lay guarded under the eye of Europe. The Cape of Good Hope, which was for centuries the limit of Portuguese navigation, has become a mere halting-place for sailing ships and steamers. The voyage from England to China has been narrowed, within one hundred years, from an eight months' to a four months' sail. These great changes have been mainly effected by the agency of steam. Steam has transformed the smaller seas into mere bridges, and England and France are securely joined, Marseilles and Algiers; while Prussian Stettin is brought into proximity with Swedish Stockholm and Russian Petersburg. The voyage to America, that remote land, which before the days of Columbus was as inaccessible as the moon, was made by him in seventy days, but is now accomplished in ten. Even Australia cannot be said to be distant; a steamer needs but seventy-five days to reach it, and ten of those are consumed on the Isthmus of Suez. No island now lies beyond the world of commerce. The most active traffic exists between places the most remote. The wool and the wheat of Australia control the price of those commodities in London, and the value of cotton in America fixes that of woven goods and even of bread in Europe.

The great rivers too have been curtailed of their relative importance, and have been shortened by steam six-fold. They can be stemmed too, which is an immense gain, for in the primitive stages of navigation they could only be sailed upon downward, from source to mouth. In 1854, four hundred steamers traversed the Mississippi and its branches, and came into contact with a region one-third as large as Europe. The Indus, Ganges, Irrawaddy, Nile, La Plata, and even the Amazon, the monarch of rivers, which drains a country half as large as Europe,

are now more or less open to steam navigation. The great river systems of central Europe too are thoroughly navigated; and Southern Germany, Trebizond, Mayence, Cologne, and London may be grouped as neighbors. The land-locked seas are reduced to insignificance, and their shores are now covered with villages and cities, from the Platten-See of Hungary up to the Caspian and the great lakes of North America.

To sum all up in one word, the mighty influence of Time on the geographical development of the earth is displayed in the clearest manner. But this influence is not the same for all localities on the globe. While there are some people and some places which are left behind, there are others which have made wonderful progress, and have taken and now hold a foremost place. And such a position is that of Europe at the present moment. Europe, the most central of all continents, in relation to the great land-mass of the earth, and also the one most equally removed from the middle point of the great water-mass, touches the whole remaining world at the greatest number of points, and this, in conjunction with her remarkably broken coast-line, so favorable to the purposes of navigation, have given her her place of command, and have assigned to England her evident rôle of mistress of the seas.

And looking from the present to the past, we see that as some great tribes of men have given the whole fruits of their natural existence to the world for its future use, so some places, and those of no insignificant size sometimes, have conferred upon the world, the trust which they once held, and now recede, as it were, from view. They were great in the past, and the results of their greatness are now incorporated in the world's life. The earth is one;

and through the agency of what we may call either time or history, all its parts are in ceaseless action and reaction on each other. Though some great districts seem now to have no part to play, the element of time draws them into the great cosmos; they once had a great share in the world's affairs, and the fruits which they brought to completion are merely in other hands. The earth is, therefore, as was stated in the introduction, a unit, an organism of itself: it has its own law of development, its own cosmical life; it can be studied in no one of its parts and at no special epoch of its history. The past and the future, the near and the remote, are all blended in a system of mutual interdependence, and must be looked at together.

This is shown clearly in the past of Asia, and the present of Europe and some parts of the new world, while the history of all central Africa seems to lie wholly in the future. Heretofore it has enjoyed no progress excepting along its northern rim. The middle portion of the old world has outlived its primitive ethnographical impulse, and sunk back into a state of slumberous inaction. Asia, to call this region by its recognized name, has projected its own life from the center to the circumference; by this I mean, that while it seems to be exhausted of its old vigor, other countries inherited its power. The population of Asia is much less than it was in the time of Alexander the Great, much less than during the Mohammedan and Mongolian conquests, when all the habitable parts of that immense continent were bound together by highways of commerce and travel. On the other hand, the coasts are now of much more value and significance than they were in ancient times, and navigation has dotted her sea outline with splendid and populous cities. These seem, by reason of the facilities which steam affords, to be brought near to

Europe; while the natives who inhabit central Asia are not only widely separated from the civilized world, but are divided up and set against each other by religious and political enmities of the most bitter kind. This is displayed in its fullest force by the comparative inapproachability of the great mountain chains, the Ural, the Taurus, and the Caucasus, and yet more by the unchanged barbarism of the central tribes, the hostile political relations, lacking all of the amenities and mutual dependencies of European policy, and the deadly antagonism of Mohammedanism and Christianity. This last is the curse which the natives of the earth have brought upon themselves. It is the clashing of religious faiths which has put the extinguisher on Asiatic progress, annihilated her enterprise, and set her in her present isolation. Still this barrier is not absolutely settled and for all time, but already it shows that it is capable of some modification. The politico-religious system of the Chinese is rending under our eyes; the old bonds which Mohammedanism once laid on Asia are now sensibly relaxed. The great highways of travel through the country of the Euphrates and Tigris and the extended archæological investigations of modern times have operated mediatorially between Europe and Asia; while steam navigation on the Danube has brought Turkey, a hitherto undissolved Asiatic element in European life, into closer relations with the great powers of the West. The great missionary enterprise, too, of modern times, has been laboring to remould the ideas of the Asiatic nations, while navigation has operated on the material and more appreciable interests of commerce and industry.

There are no possible limits to be assigned to the perfectibility of the globe as the abode of man; no possible

bounds to his enterprise. The construction of a canal through the Isthmus of Panama would bring the eastern coast of Asia seven thousand miles nearer than it is now to the Atlantic shores of America and Europe. By saving the mere doubling of Cape Horn, one-third of the periphery of the globe would be annihilated, so far as the labor and expense of navigation are concerned. North America would nearly double its resources when its Atlantic and Pacific coasts stand in close connection and interdependence. The projected canal at Suez would exercise an unbounded influence over Asia in binding it anew to Europe. The building of highways through the passes of the Ural, the Caucasus, and Himalayas is yet to be accomplished; and only now are great roads constructing over the Rocky Mountains, welding North America together. The construction of railways on the high plateaus of central Africa will transform that vast undeveloped district, so rich in resources for the future. The changes which art is yet to effect on our globe are beyond all possible computation, and it might be said, beyond any possible exaggeration.

We turn away from these glances into the future to look upon the past, the long ages when men lived in rudeness and ignorance, having no art, and knowing nothing beyond the little tract where they were born, and to which they remained chained. There was no binding of shore to shore, and of continent to continent, through the mediatorial agency of seas and oceans. And this gave to the continents a far greater individuality than they have now, and a much higher degree of apparent influence than now when we cannot view them excepting as parts of the great complex which forms the world. The wanderings of the old nomadic races, the enlarging of the domains of culture, the transfer of the natural productions of all climes, as

well as the traditional ideas of all lands, proceeded from the central portions of the ancient world toward the extremities. The manner of this progress, following as it does the order of history, displays more clearly than almost anything else the close dependence of all national development upon geographical conditions, and their indissoluble connection. Without this connection the order of historical events would have been completely changed. In no instance has there been self-evolved progress in the North, East, South, or West; it uniformly began at the geographical center, at the point of conflict between the Orient, the Occident, and the tropical South.

Western Asia, northern Africa, and southeastern Europe were the homes of the earliest culture, and it is to them that all other parts of the world owe the light which they enjoy, though they may have received it at second or third hand. The territory of which I speak extended from the highlands of India to Italy, and from the Nile to the Don, including the valleys of the Euphrates and the Gihon. This broad and fertile reach of territory has been the fruitful mother of the world's present thought and culture. Nor must we overlook the fact that, despite what was said above, regarding the oceans as the greatest barriers to the spread of civilization, that smaller seas aided it, for the very country of which I speak was intersected by five important seas, and to them it is under immeasurable obligations for its development. This Asiatic-Africo-European belt has exercised the greatest influence on all the course of human affairs, on all colonization, on the differing of races and languages, and the arts of war and of peace, over the habitable world. This territory lies as the background of all the events of history, and has given to every one its distinctive character and its appro-

priate place. Nor can we in the future dispense with the element involved in this, of historical occurrences yet to come dependent on past geographical conditions, although this will be far less marked than it has been in the past. It demands and will demand a far larger measure of investigation and thought than it has yet received. Whatever independent progress the New World and Australia may seem to be making, and whatever interest they may awaken in the minds of students, not even they can be looked at without regard to their relations to the ancient historical lands, the source of all the inherited culture which they are enjoying in their vigorous youth. India, Egypt, Palestine, Greece, and other countries still stand out as the formative lands of all modern history, and we cannot study the present without studying them. They are to the student what Plutarch's Lives are to the biographer, the imperishable and unequalled models which gain new luster as time rolls on. It is therefore not without reason that ancient geography ought to be subjected to a more systematic treatment than the geography of the Middle Ages. The latter, though not unworthy of a large place, had no relations of special importance to the whole world, to the study of the physical conditions of the most imposing objects of nature, to the connection as cause and effect of events past, present, and to come.

From these foundation principles, we advance to a more full study of the configuration of the surface of the globe, for which we are now in a measure prepared.

PART II.

A more extended Investigation regarding the Earth's Surface.

It is the province of Hydrography to deal with the oceanic world; Geography proper concerns itself simply with solid forms. The Hydrography of the globe we must pass over, however. Aside from the fact that it would lead us into studies of the most protracted nature, it forms strictly one department of nautical science. Besides, there is the less occasion to speak of it here at length, that works of great excellence have been published, relating to that branch. We turn therefore to the land, and shall study the world of waters only so far as it exerts influence on the land.

By land we mean the islands as well as the continents, for, as remarked before, the difference between them is merely relative. To the land division of the globe, however, belong all rivers and the internal fresh water lakes, however large. The basis of difference does not lie in the fact that one part of the globe is water, the other part land, but in the fact that one is a tract of uniform evenness, the other of constantly varying surface, the internal rivers and lakes only being frills, so to speak, to the elevated region, and not sharing the sea level of the great oceanic mass. Uniformity of surface is then the chief characteristic of the sea; a lack of it, of the land. A mathematical level is

a thing unknown on extended districts, and an approximation to it is very rare. Even the basins of former seas do not display a perfectly level bed. The plains of North Germany are characterized by this billowy rolling. The flats along the Danube, in Hungary, and along the Po, in North Italy, have really important deviations from a true level, though the eye is not able to discern them. Milan is four hundred feet above the Adriatic; but the eye does not discern that it is not at the center of a plain as perfect as the surface of the sea itself, and yet that plain does shelve gradually away till the Adriatic checks and defines it. Pesth is two hundred and fifteen feet above the ocean level, yet the gradual decline to the Black Sea is undiscernible to the eye. The immense plains along the Amazon, even the celebrated llanos on the Orinoco, which Alexander von Humboldt likens to inland seas of verdure, have a not insignificant slope from west to east. The middle point of these llanos near the City of Calabozo, about 100 geographical miles from the sea, he found to be 180 feet above the sea level; far lower indeed than Milan or Pesth, relatively, yet at a perceptible elevation. All of these plains were once the bottom of the sea; the Adriatic laved the base of the Apennines and the Cottian Alps, and the Atlantic swept westward over the llanos of the Orinoco and the Essequibo, having the Sierra de Venezuela on the north and the Sierra Parima on the south, till it was checked by the Cordilleras of Merida and Pamplona.

Depression and elevation, then, are the characteristics of the land. They are both measured from the level of the sea; their absolute altitude is reckoned from the imaginary sea level, extended over the whole globe. Their mutual relations to each other are determined from their relative heights. The absolute elevation above the level of the

ocean can be determined in a number of ways. If the heights to be measured are in the immediate vicinity of the sea, a simple system of triangulation will effect it. If they are removed from the sea, the difficulties are greater, and increase according to the distance from the sea. The heights of great inland mountains are determined by complicated operations with the spirit-level, protracted trigonometrical calculations, the unwearied and skillful use of the barometer, and constant appeal to the boiling point of water. The description of these methods falls within the province of Physics.

As the determination of the heights of the loftiest mountains could not be made before the appointments of scientific explorers have attained to a certain degree of accuracy and delicacy, the knowledge of them in former times was almost wholly relative. The inquiries of La Condamine, Saussure, and de Luc, in the Andes and the Swiss Alps, are almost the only ones to be trusted among those of the older observers. All unscientific travelers without accurate instruments confounded absolute heights with relative heights, and innumerable errors crept therefore into the earlier text-books. It is only within the most recent times that Hypsometry has attained to the dignity of a science.

To meet and counteract the errors alluded to above, and current in the loose language of popular speech, we shall use a new and indeed arbitrary terminology,—arbitrary because the data which mensuration will sometimes furnish are now, in part, wanting. We will divide the earth not relatively, but absolutely, into highlands and lowlands. The great districts often met, whose elevations are very moderate, we call lowlands. They are, for the most part, immense plains, varied but little above the level of the sea.

The great districts which inclose mountain ranges we call highlands, and sometimes plateaus. True highlands can often embrace very extended and elevated plains, and these plains again may include hills and mountains. This does not affect their character as highlands, which lies in the fact of elevation rather than in more or less modified variation of surface. There may be vast variety in the physical manifestations of a great plateau district, entirely independent of the relative effects produced by the distribution of its surface into plains, rolling land, hills, and mountains.

In the lowlands there may exist hills to some extent, and these may even be combined in ranges, provided only that they do not violate the uniform characteristics of the district in which they are found.

The highlands are generally met with in the interior of the continents; the lowlands at the coasts. Yet there are exceptions to this.

In the transitions from lowlands to highlands there is great diversity. We can speak of three distinct bases of discrimination: a sudden and abrupt ascent; a rise in elevation so gradual as scarcely to be perceived; and a terrace formation. Yet in these there is a blending of one variety with another; there is no place sharply marked, where we can say that one form ends and another begins. There are constantly found modifications of these three transitional phases. The plains along the Indus and the Ganges rise sharply to the plateaus of Thibet. The flat Pacific coast of South America is exchanged with equal abruptness for the highlands of Peru. The transition is a gradual one from the lowlands of North Germany, along the Baltic and the North Sea, through Saxony and Bohemia to the Bavarian highlands, north of

the Alps. The Spanish highlands form a series of terraces, increasing in height from south to north. The immense plateaus of central Asia are also terrace formations, of diminishing elevation, as they advance to Siberia; so, too, are the eastern plateaus of Peru, falling off in altitude toward the plains of the Amazon.

Just as varied are the heights taken from the sea level of the leading plateaus. Yet they never rise to a point of elevation comparable with those of isolated mountain peaks or ranges. These attain, in no insignificant numbers, the height of 24,000 feet, while some ascend thousands of feet beyond that. In Mount Everest, of the Himalaya chain, the loftiest summit yet measured (29,000 feet) is found; although it may be that future investigations more to the south will disclose yet greater heights.

Highlands.

Continuous highlands or plateaus seldom attain an elevation greater than a half or a third of the loftiest mountains; the most elevated range in altitude, from 8000 to 12,000 feet above the sea level. On an average, they lie about 4000 to 5000 feet above the sea. We take the last height as a convenient point of demarkation between the two classes of highlands—those of the first and those of the second magnitude. It is an arbitrary point, of course, and the division there must remain, without a natural base to rest upon, till more results in Hypsometry shall have determined the real point of average between the combined lowlands and the combined highlands of the earth's surface. Meantime this division will be of great service to us in enabling us to bring into a definite and appreciable classification many facts which would otherwise not be so well understood in their relations.

Highlands or Plateaus of the First Class.

By plateaus of the first class, we mean those high, continuous plains which lie at the elevation of more than from 4000 to 5000 feet above the sea level. The extreme height to which such plateaus rise is a fact yet to be ascertained. At an elevation of from 4000 to 5000 feet the highlands of the first class merge into those of the second. The point of transition is, of course, very difficult to fix with precision.

The high plateaus of Asia rise more than 14,000 feet. They inclose the head-waters of the Ganges and the Indus. All central Asia is a vast congeries of highlands; but, as a body, they by no means belong to the most elevated of the globe. They are colossal in their length and breadth, but not in their uniform altitude. In the latter respect, they are far more varied than is generally supposed.

The plateau of Thibet attains, in its whole great extent of 1800 miles in length and 500 miles in breadth, an average elevation of 10,800 feet above the sea level. In some cases it rises, of course, much higher, as, near the holy lake Manasarowar, for instance, where it is 14,000 feet above the sea. Others sink, as at Ladakh, in Little Thibet, to an altitude of about 9000 feet; so, too, Gertope, in the region remarkable for its goats and the rich shawls manufactured there, and Shiffke, are about 9804 feet above the sea. The plateau of Great Thibet, east of Lassa, the capital, and north of the Upper Brahmapootra or Yam-Dzangbotscha, is 9000 feet in elevation. There are also districts filled with mountain groups of great heights, but where the depressions sink to the level of the valleys of the Indus, Sutlej, Brahmapootra, as low indeed as 5460 feet,

as at Cashmere, so that there is no lack of diversity in the great plateau of Thibet.

The plateau of Mongolia, or more exactly the desert of Gobi, can be ranked only on its lower edges, where it touches the Chinese frontier, as of the first class, although in extent it is twice as large as the great plateau of Thibet. Only near the north bend of the Hoang-Ho and near Peking does it reach an altitude of 8000 feet, and gradually sinks away as it advances toward the northern frontier of the Chinese territory, to 5100 feet, and farther north to 4000 feet; in the middle portions of the great table-land it is depressed to a height of 2400 to 3600 feet; it rises again at the head-waters of the Orkhon and the Toola to an elevation of 4620 feet, and falls off in terraces toward Kiakhta, near the northern boundary, where it is 1330 feet high, Selenghinsk, on the Selenga, where it is 1632 feet high, and Berch-Udaisk, where it is 1458 feet high, till it reaches Lake Baikal, 1332 feet above the sea level according to Humboldt, though Erman makes it greater.

Western Mongolia, (west of the meridian of Lassa, and west of the point where the Tarine flows into Lake Lop,) upper Bokhara, and upper Toorkistan were formerly considered to be a highland district; this is now subject to doubt. We shall discuss this further on.

Africa, too, has highlands of the first class, which, however, do not rise to the extreme height of the plateau of Thibet. As in Asia, so in central Africa, the old supposition of the existence of a plateau of colossal extent has been very much done away with by the more exact and critical modern investigations. The strip of territory lying between 4° and 10° north latitude has been demonstrated by Barth and Vogel to be destitute of highlands. The range of mountains announced as discovered by Mungo

Park, and called the Kong Mountains, is proved to have no real existence, and of course his statement fails of verification that that range is the northern limit of an elevated central plateau. The peaks which really do rise in the Kong territory form no continuous ridge; they are mere isolated groups of moderate height. Between these groups the lowlands continue toward the south, in an unbroken level, for an immense distance. How far south of the equator the central African plateau begins, is yet unascertained, for the snow-tipped peaks of Kilimandjaro and Kenia, discovered by Rebmann and Krapf, in the parallel of Mombas, 1° to 3° south latitude, are of immense height, it is true, but they do not demonstrate the existence of a plateau of the first class there. They rise out of table-land about 2000 feet above the sea level, which Krapf explored in the year 1849.

The Abyssinian plateau, on the contrary, takes rank among the most elevated on the globe. At 10° north latitude, south of the sources of the Blue Nile, lies Upper Abyssinia, or the kingdom of Shoa, with its capitals, Ankobar and Angolalla, 10,000 feet above the sea. Still farther to the north, in the ancient kingdom of Gondar, the German naturalist Rüppel ascertained the level of Lake Tzana to be 7000 feet above the ocean; to the southward of that the land rises to a still greater height, and northward of Gondar the plateau ascends to an elevation of 8000 feet, and mountains are met with 14,000 feet high. The terrace of Axaw on the east is 6650 feet above the Red Sea, which lies along its border.

To the south of Shoa lie the highlands of Kaffa and Enarea. All travelers agree in the statement that the inhabitants of that region are light-complexioned; and Johnson draws from this the conclusion that the central

plateau must rise to a height of over 10,000 feet to harbor people of a whiter hue than the dwellers of the less elevated localities. He saw a number of men of light complexion who came as far as from the fifth degree south latitude, not from mountain homes, but from high table-lands.

The plateau of South Africa rises at Lattakoo, in the country of the Bechuanas, north of the Orange River, to the height of 6000 feet. To the east, near the Snow Mountains, where the river has its source, it ascends to an altitude of over 10,000 feet. To the north, discovery had made great progress since 1849. There, on a broad plateau, Oswell and Livingstone brought to the knowledge of the world the existence of Lake Ngami, whose surface is 2825 feet above the level of the sea. The plateau which includes this lake at its place of deepest depression cannot be less than 3000 feet high, and at some localities yet higher. Still more to the north, at latitude 14° south, on the water-shed between the Zaire or Congo on the west and the Zambeze in the east, the plateau reaches an elevation of 5000 feet, according to Livingstone. Yet farther to the west, it rises still higher and takes undisputed rank among plateaus of the first class. There, at 18° south latitude, Galtne, on his journey of discovery in 1850, ascended the table-land of Ovompâ, a region of great natural productivity. On the way thither, going from south to north, at 21° south latitude, and therefore in the parallel of Lake Ngami, but about 500 miles westward, he ascended north of the Swakop River, the table-land of Demara, which he found to be 6000 feet high. From that plateau mountains, Koniati and Ometako, for instance, rise to a height of 8800 feet. From the Swakop River to Lake Ngami there is a continuous plateau.

The high table-land of southern central Africa does not then extend, as was once supposed, as far north as 9° north latitude, nor even to the later limit of $4\frac{1}{2}^{\circ}$ north latitude; but at about $4^{\circ} 10'$ the distinction between low-land and highland seems to be sharply drawn, as the cataracts which terminate the navigation of the White Nile indicate. Here Father Knoblecher turned back in 1849, but he ascended the first of the mountains which there began to rise; his eye reached onward to mountains very near or on the equator. He says that those high mountains stand upon an elevated table-land. Thus, here at the source of the White Nile we have a plateau seemingly of the first rank. From such a plateau it is probable that the snow-capped mountains, seen by Rebmann and Krapf in the neighborhood of the equator, rose, which they thought, approaching from the eastern coast, held the source of the Nile.

At the northwest of Africa, too, at 10° north latitude, the territory which feeds the springs of the Senegal and the Niger is supposed to be a plateau of great elevation and of great extent. But at present our lack of knowledge prevents our attaining certainty regarding it. No thorough system of measurement has been yet applied there.

America possesses a number of plateaus of the first class. To the most prominent of these belong the ones which were first thoroughly studied by Alexander von Humboldt. It is to him that we owe our first accurate impressions of table-lands which, before his day, had been indiscriminately confounded with mountains, and had had no place assigned to them in the department of Geography. Doubtless, too, great prominence was given to plateaus at the outset; they were pushed into unseemly pro-

portion to other matters as well worthy of investigation, but they have come into their true place, and now only wait the development of new facts regarding the size and height of some, to be properly understood and appreciated.

The measurements made in North, Central, and South America give the following results; much more complete, it may be remarked, than the results yet gained in Asia and Africa.

To the plateaus of the first class belong in America, at latitude 0° , the plain of Quito, almost 9000 feet above the sea, (Los Pastos in the north being near 11,000 feet,) and to the south, at 17° south latitude, the plateau of Upper Peru. Here the great Lake Yiticaca is found, 12,000 feet above the sea; eastward of the lake, the table-land rises yet higher, and at Alto de Toledo it is 14,000 feet in elevation, as high as the highest part of Thibet. At 20° south latitude, south of Lake Yiticaca, is the City of Potosi, whose streets are 12,822 feet above the Pacific.

In Central America is found, at 20° north latitude, the extended table-land of Mexico, 500 miles wide, rising to a height of 7000 feet, and farther to the north, in New Mexico, the plateau of Santa Fé, 35° north latitude east of the Rocky Mountains, and 7100 feet above the sea. The table-land on the west side of the mountains, and toward the Great Salt Lake, is undoubtedly just as elevated.

Europe and Australia are wanting in plateaus of the first rank, and in general the whole immense flat northern districts of the globe, though we are not yet quite familiar enough with the extreme north of America to speak with entire confidence regarding it.

Plateaus of the Second Class.

Elevated plains which are at once continuous and bounded by a definite line of demarkation, and which do not attain an altitude of more than 4000 or 5000 feet, are considered plateaus of the second class. They are far more general over the whole earth than plateaus of the first class; in every one of the great divisions of the globe they appear in the utmost possible diversities of elevation, sometimes so gradually ascending that the lowest limit is hardly to be perceived. This makes it not only expedient but necessary to assign to plateaus a fixed though arbitrary system of classification, for without it we could attain to no thorough view of all their relations. This general system must afterward be confirmed and justified by protracted special investigations.

That not all the vast plains of Central Asia, from Thibet to the Altai Mountains, and from the Belur range to the Chinese Gobi, belong to the first class of plateaus, has been demonstrated by the Russian measurements, made by Fuss and Bunge in 1832, between Lake Baikal, Kiakhta, and Peking, and rendered highly probable by the investigations of Klaproth, Humboldt, and Zimmermann. Toward the northwest the plateaus generally sink from the moderate elevation of the Middle Gobi, 4000 feet, to Lake Baikal, 1332 feet above the sea, Lake Zaison, not 1000 feet above the sea, and the border of the plateau at Choi-mailocha, the Chinese frontier post on the Siberian line, 1000 feet above the sea, then to the lower border of the plateau of Bookhtarminsk (936 feet) and Semipalatinsk on the Irtysh, (708 feet,) where the great Siberian plain begins. In the valley of the Tarim and of Lake Lop, pomegranates and grapes thrive, and cotton, which has

been raised of an excellent quality in Eelee, is found at a height of from 1200 to 2000 feet. And in contrast with the great arctic plain of Northern Asia, not 500 feet above the level of the sea, this central plateau will take its place as distinctively of the second rank.

The plateau of Persia lies on the border of both classes; for while the central portion touches 4000 feet, some parts rise much higher and some sink much deeper than the normal point. These balance each other, and the average is about the maximum elevation of plateaus of the second degree.

East of the Persian plateau lies the plateau of Cabool, 6000 feet above the sea. On the northern edge of Afghanistan is the plateau of Bamain, 7500 feet in elevation. More to the south is the high plain of Candahar, being 3500 feet, and the City of Candahar, 3264 feet above the sea. The plateau of Kweltah west of the Bolan Pass is 5220 feet. Still farther to the south is the great plain of Beloochistan, 7000 feet, with the City of Kelat, 5418 feet above the sea.

In the central part of the eastern Persian plateau in ancient Gedrosia, Drangiana, and Parthia, and Lake Zareh, the depression is the lowest. At Lake Zareh the elevation is 2400 feet; at Herat, more to the north, 2628 feet. In West Persia, on the meridian of the Caspian Sea, it rises higher; on the northern edge at Teheran it is 3672 feet; at Schabred, southeast of Astrabad, it is 4000 feet; at Kasbin, west of Teheran, it is 4000 feet; and at Samegon, 5700 feet. The lowest depression at Com and Kashan is not 2000 feet above the sea. Toward the north-west Persia thrusts up a short arm into the adjoining territory of Armenia. This is the highland of Ayerbaijan, Zoroaster's "Land of Fire." This connecting plateau of

7000 feet elevation belongs to the first class. To the west of this the plateau of Armenia extends in varying range of elevation, from that of Lake Van, 5124 feet, to the plain of the Aras, (the ancient Araxes,) on which the double cone of Ararat rises to a height of 14,656 feet. But the table-land at the northern base of Ararat, the site of Erdschmiazin, is only 2860 feet high, Erivan a little higher, and Erdzeroune, on the plateau of the Taurus, the plain of the Upper Euphrates, 5730 feet.

The plateaus of Asia Minor embrace wide plains extending through the whole of the country, at an elevation toward the east, in ancient Lycaonia and Cappadocia, of 3000 feet, and sinking toward the west to 2000 feet.

To the plateaus of Armenia and Lycaonia, Strabo, whose home was there, and who carefully studied them, gave the expressive name of *ὄροπέδια*, *i.e.* mountain plains, a term which corresponds remarkably with our word plateau, but which, as Humboldt has remarked, was not of much use among the ancients. Strabo, however, directed attention also to the Oropedia of Sicily and India

In India, Deccan displays similar formations, which rise gradually from south to north in Mysore, in Poonah of the Mahrattas, and in the table-land of Vindhya and Malwah, to 2000, 3000, and even 4000 feet. Deccan enjoys an admirable climate and the richest abundance of all natural productions. China too must have plateaus, for the Chinese word *youen* indicates very clearly a large elevated plain.

In Arabia the plateaus of the second class are largely found, and their height ascends from north to south, instead of from south to north as in Deccan. The Syrian Hauran is 2000 feet high, the plateau of Damascus 2200 feet, the plateau of Taif, above Mecca, 3000 feet, the plateau of Sapaa, in Southern Arabia, 4000 feet.

In North Africa that portion of the great Sahara which has heretofore been considered a low plain, lying between Tripoli and Lake Tchad, has been ascertained by the German explorers, Overweg and Vogel, to be a table-land of the second class, ranging in elevation from 1000 to 2000 feet. It begins at the Chorean plateau (2000 feet) in the south of Tripoli, and sinks to an elevation of 800 feet in the neighborhood of Lake Tchad. The average altitude is about 1500 feet. This moderate elevation of Sahara corresponds with the equally high plateau of Cyrenaica, 2000 feet.

The Atlas plateau, in the northwest of Africa, rises to a greater height—2000 to 3000 feet; the upper course of the Draa, near the Sahara, being 3000 feet; the high, broad table-land on which Timbuctoo lies, according to Renon's measurement, is 1500 to 1800 feet above the sea.

In south Africa the low, or rather the moderate plateau, which borders the district of the Bechuanas on the north, rises, as it advances toward the lower rim of Africa, at Cape Colony, to an altitude of 3000 feet.

America has many plateaus of the second range of elevation, but her highlands of the first class are so imposing in extent, as well as in elevation, that they have been more carefully observed than the table-lands of the second class.

Along the eastern slope of the Andes, on the same parallel with the great plains of the Orinoco, the Amazon, and the La Plata, these plateaus extend, touching the base of the mountains, and appearing rather as terraces, or vast plains of transition, from the highlands to the lowlands, than as independent forms. Where Alexander von Humboldt measured them, west of the low plains of the Amazon, he found their height, measured from the

sea, to range from 1050 to 1200 feet; he describes them as having the appearance of vast plains, and as differing from the lowlands of the Amazon only in their greater elevation; their slope toward the narrowing of the Pongo de Mauseriche being too slight to be appreciable.

Between the threefold forks of the Northern Andes, Humboldt ascertained the heights of ten plateaus, extending as far as the plains of Orinoco, and called by the various names, according to their elevation—*Tierras templadas*, or temperate districts, *Tierras calientas*, or warm districts, and *Tierras frias*, or cold districts—varying in height from 1800 to 6600 feet, the highest belonging clearly to the first class of plateaus.

The mountains of Brazil are interspersed among plateaus of the second class. The Brazilian mountains are not true ranges, but lie in groups, their height varying from 2700 to 5700 feet, and between them are the vast elevated plains, called *Campas*, which are true plateaus of the second class.

The southern point of South America, south of the Rio Negro, as far as the Straits of Magellan, known as the plateau of Patagonia, is a true table-land of from 1200 to 1400 feet in height. It is composed of ragged strata of porphyry or of vast lava-masses, and has been explored by Captain Fitz Roy, in 1837, from the mouth of the Santa Cruz River to the snow-capped Andes in the west. The plateau diminishes gradually in elevation from west to east, till it touches the sea line.

In North America the broad plateau extending through Northern Texas and the Indian Territory, and lying on both sides of the Arkansas River, increases in elevation gradually from St. Louis, on the Mississippi, less than 500 feet above the sea, to Santa Fé, on the upper course of the

Rio Bravo, 7000 feet above the sea. It ascends so slightly that the rise is imperceptible to the eye, the broad plains there taking the name of prairies. St. Louis is 420 feet in absolute elevation; the eastern Arkansas plateau 1500 to 3000 feet; the high western Arkansas table-land from 3000 to 7000 feet, where, at the point of greatest altitude, lies the City of Santa Fé, in the Territory of New Mexico, 7047 feet above the sea. This broad, sloping tract reaches out to a great extent at the north, crossing the Missouri, and embracing the colossal North American lakes. Lake Huron and Lake Michigan, about 578 feet deep, and Lake Superior, 627 feet deep, lie in vast hollows in that great continuous plateau, which extends into the British Possessions, rises again to 800 or 1000 feet in elevation, and is rocky and craggy, yet not enough so as to take the name of a mountain chain, but simply to form a clearly-marked water-shed, which Fremont and Nicollet have measured.

In Australia and Europe plateaus of the second grade of elevation are not wanting. In Australia, however, they are limited to the triangular district in the southeast, which has become the place of settlement for the chief English colonies, and which, bearing the name of King's Table-land, rises to a height of 2500 feet, and occupies the largest area of all the Australian table-lands.

In Europe this physical feature is displayed most distinctly in the Spanish plateaus, which occupy by far the largest proportion of the entire peninsula. Madrid lies on one of these plateaus, at a height of 2100 feet, five times as high as Paris, on the Seine, and as high as Innspruck, in the very heart of the Tyrol; Toledo, in the valley of the Tagus, is 1734 feet above the sea. The average elevation of New Castile, the central part of Spain, is

2000 feet. Old Castile, which borders it on the north, separated from it by the Guadarrama ridge, is about a thousand feet higher. Burgos, in the center, is 2700 feet above the sea; Segovia, to the south, 3100 feet. The average elevation of Old Castile is 3000 feet.

Then comes in natural order the Bavarian plateau, in southern Germany, ranging from 1500 to 1600 feet high, a broad table-land, on which lie Munich and Augsburg. It extends along the course of the Danube from west to east, from Lower Switzerland to Ratisbon.

According to the mean measurements of Humboldt, the lower plateau of Auvergne, in southern France, is 1040 feet in elevation; still less in altitude (840 feet) is the plateau of Burgundy and Lothringia, between the Vosges and the Ardennes. Limousin, Aveyron, la Forez, Monts, and Côte d'Or are plateaus.

The plateau of Lothringia, whose mean elevation is 648 feet, lies between the Rhine and the Moselle. The plateau of Luxemburg extends northward to the Eifel, where Prum lies, and to the Ardennes, where Malmedy, Eupen, Namur, Liege, and Aix-la-Chapelle lie.

In Middle Germany, a series of plateaus of the second grade begins in Upper Hesse, and extends eastward, crossed by mountains and valleys, traversing Upper Silesia and Galicia, and running along the northern side of the Carpathian Mountains to Podolia, on the Dnieper, thus embracing a strip extending through the larger part of central Europe.

A line of plateaus begins still farther to the north, at the low hills of Jutland, crossing Holstein, Mecklenberg, the whole southern edge of Pomerania, and extending to Lithuania and the Valdai Hills. It is characterized by a band of inland lakes, whose basins it incloses, and is

crossed by the valleys of the Oder, Vistula, Niemen, and Duna. It has been called the Pomerania lake country. In the hollows where the lakes lie, (whose surfaces are, at the highest, not more than 300 feet above the sea,) and yet more in the depressions, where rivers break through, the level descends to as low a point as that of the great plain of Central Europe; but at other places it rises to an elevation as high as 500 feet, and so touches upon the limits of plateaus of the second range. Many parts of this broad upland may possibly be formed of shifting sand dunes which have been gradually piled up along the sea line. The plateau reaches its highest point at the eastern end, in the Valdai Hills, where it averages 1000 feet in elevation. The highest point is 1100 feet. East of the Volga, which rises at the eastern side of these hills, the plateau falls off by imperceptible steps, till it is lost in the great Russian plain.

In the peninsulas of Southern Europe, as in the Morea, (2000 feet,) and in the Crimea, (800 to 1200 feet,) the plateau again appears in not insignificant proportions.

The lower range of plateaus, it will be seen, is far more frequently met with through all parts of the earth than the higher, yet both combined occupy a larger share of the surface of the globe. We can designate them as sharply defined and broadly massive elevations, in contradistinction to the long, narrow, and broken masses which have received the name of mountain chains. The latter have too often been confounded with the former and have received from geographers a treatment disproportionately full in relation to their claims. The plateau has been until recently an almost forgotten geographical element. Humboldt restored it to its rightful place; by many hundreds of measurements he has accurately settled its form, its effect on

climate, on isothermal lines, on agriculture, on the physical and moral life of nations, and even on the course of human history.

In closing this attempt at a general consideration of plateaus, I must confirm the reproach which Humboldt has cast upon most geographers of this day for their abuse of the word plateau. And I must at the same time admit that it is justly due to some parts of my own "Erdkunde," where I have considered the plateau systems of Central Asia and Africa. When I wrote the pages of that work, thirty and more years ago, there were no scientific measurements then made of those regions, and the general ignorance led to a premature generalization, in which I used the ascertained features of the New World as probably in analogy with the unexplored center of the Old World. This use of really untrue analogies was carried by others to great lengths, and choratographers went so far as to depict the country according to the hypothesis of those who had written at first hand, and after using all the lights then existing, but who had never supposed that what they had indicated in general terms, would be afterward made so definite and real to the public eye. Those untrue statements of my own, I must leave however just as they are, and rejoice that the great advance of science has led to the accurate knowledge of the great plateaus of which the civilized world then knew but little. One word more: I set the lower limit of plateaus of the second grade at 500 feet, lower therefore than the great master in Physical Geography set his.

"Elevations of the soil," says Humboldt, "which do not display a marked difference in climate and vegetation from the country around them, are not rightly called plateaus." His meaning is, that the name does not relate to

absolute height measured from the sea, but harmonious climatic relations existing between contiguous districts, one of which is more elevated than the other. Highland and lowland are therefore to him words of unfixed meaning, if they do not stand in the contrast of height, climate, relief, and rates of temperature. Humboldt therefore did not consider the depression of Central Asia, at the Tarin-gol, as a plateau; and table-lands from 200 to 1200 feet in absolute elevation, *i.e.* from the sea level, are passed over by him as not worthy of the same name which he applied to the plains 6000 to 10,000 feet above the sea.

Dealing as I do with the elementary features and the physical contrasts of countries which for the most part are now thoroughly explored, I prefer, for the purpose of elucidating the subject of Physical Geography, to consider the plateau as beginning at 500 feet above the level of the sea. By comparing the plateaus of both hemispheres it is not difficult to deal with a variety of features, and to make a number of discriminations which, without an absolute standard, it would be impossible to make.

We pass to the consideration of the much more varied and more imposing characteristics of mountains.

Mountains and Mountain Lands.

Mountain lands cannot, in the strict use of language, be compared with plateaus, except in way of contrast, because they are not uniform, broad, and sharply defined tracts, but extend in a linear direction, having as their chief feature the longitudinal axis of the mountain chain. Groups of mountain ridges may be separated from each other, or may be united in any coherent way which does not make them continuous, and yet, despite the want of continuity, form a perfect whole.

Mountains, with their fissures, chasms, abysses, valleys, ravines, clefts, precipices,—in a word, their varied diversities of feature, broken through in every direction, the whole chain rent into fragments by these transverse breaks, are in direct contrast with plateaus. They have quite often a common range of elevation, which, measured from the sea level, is not unfrequently much greater than the districts lying at their base. Yet this relation is only incidental, it is not essential. There is no necessary connection between the height of the outlying plateau and the height of the mountain range. In Switzerland the mountains rise to the altitude of 13,000 or 14,000 feet; the country at the foot of the Alps is but 1000 to 2000 feet above the sea. Here the distance between the summit and the plateau at the base suggests no relation between them.

The distinctive characteristic of a mountain land is the height of isolated groups. Great differences of elevation within small distances characterize mountain regions; small differences within great distances characterize plateaus. The plateau depends upon uniform evenness of surface, or an approximation to it, over a large extent of territory. The mountain range is the exact opposite, the development of all kinds of extremes within a limited space, and the consequent individualization of the locality where it stands. Mountain lands cannot therefore be identified with the type of the highland and the plateau. The mountain chain has a character of its own, whether existing in unbroken unity, or subdivided into subordinate ranges, ridges, and spurs, and whether the summits are conical or sharply pointed,—whether also of moderate, medium, or loftiest elevation.

And high as mountains rise, their height is equivalenced

by the depth of the depressions which form their valleys; the higher the mountain, the deeper the abyss which cleaves to the base. The immensely elevated peaks of the loftiest chains find their correspondence in the narrow ravines and the mountain lakes at the foot; the precipitous summits of the great American chain have their barrancos in the Andes and their cañons in the Rocky Mountains. The valleys are in natural contrast with the summits. They have just as little of the uniformity of lowland plains as the mountain tops have of the uniformity of elevated table-lands. They are infinite in variety, highly individualized, and always adapt themselves to the characteristics of the chain which conditions them. The mountain, too, has no uniformity in its character; it embraces within the smallest compass the production of all climes, and unites the characteristics of both highland and lowland. Mountain regions have therefore had a great influence in history and in the development of humanity, even greater than the more monotonous plateaus, which in general harbor nomadic races and give little encouragement to permanently settled people. For this reason the geographer cannot, like the geologist, classify high table-lands and mountains together; he cannot draw the same inferences from the plateau as from the mountain range; to the geographer the plateau is not a lower type of mountain, but the two, in their relations to man and to history, suggest entirely different results and condition entirely different processes.

And yet it must be confessed that mountains do stand in intimate connection with plateaus of both classes, and that the transitions from the one form to the other are well worthy of study. Yet the present lack of correct measurements has made this little understood.

It is not the element of height alone which gives mountains their significance. There are many other features, which are little studied, yet of real import. It is, however, not a matter of indifference whether a chain thrusts up its peaks 1000, 5000, 10,000, or 20,000 feet, and the height has been made and will continue to be made a subject of careful investigation. In reference to height, we distinguish what, in a general sense, we call mountains,* into hills, mounts, and mountains of various degrees of magnitude. Yet the height of the highest range, in comparison with the diameter of the earth, is insignificant, only about $\frac{1}{1700}$, and the combined mass of mountains are of no more account in comparing them with the entire mass of the globe, than the roughnesses on the rind of an apple, or perhaps more exactly still, than those on the shell of an egg. The combined mountain systems in the world would not suffice, if transferred to the North and South Pole, to fill out the earth to such an extent that the polar and equatorial diameters would be equal.

In following out his profound scientific investigations, Alexander von Humboldt, in order to ascertain the center of the earth's gravity, taking into account the existing elevations above the ocean level, was led to the conclusion that too great importance was formerly assigned to mountains in their relations not to the course of history, but to the earth as subject to mathematical laws. Very careful observations revealed the fact to him that all the mountains of France, if reduced to a level and spread out, would raise the grade of the whole country to a height not more

* The English does not convey adequately, certainly as idiomatic English, the fullness of the German classes, Berge, Vorberge, Hochgeberge, Alpen, and Riesenberge.

than 816 feet above the sea line. All the mountains of Europe, distributed in like manner, would raise the level to only about 630 feet. In Asia the same process would make the vast plain only 1080 feet high, in North America 702 feet, in South America only 1062 feet; while the mountains of the entire globe would raise the level to only 947 feet above the level of the sea. So insignificant are the combined mountain systems of the earth in respect to size, in comparison with the immense body on which they stand, though their importance is great when we regard their influence on the localities where they are found. Yet in this last regard, mountains deserve careful study, for they not only exercise and have exercised a great influence over nature and man, but they serve as our best key to open to our view the internal structure of the earth.

Some mountains, though of great height and broad base, like Etna, Vesuvius, Teneriffe, and many volcanoes, belong to no true mountain system; and even when they lie near together, and yet have no inner principle of unity, they are not spoken of as a chain or a range: they make merely a mountainous district. It is the repetition of the common type and the existence of a continuous valley which gives a right to use the names chain and range.

The linear extent and height of mountain ranges vary very much; no definite limits to these can be assigned. Yet there are few chains which are less than 25 miles long and 1500 feet high. Other features are necessary in order to determine the strict application of the word chain or range; one is a ridge-like or comb-like aspect; (that it should be a water-shed is not essential, although very common;) another feature is that the rock composing it should be of the same geological formation. Sand dunes, although occurring in regular and ridge-like uni-

formity, like those in Holland, and looking from a distance like a mountain chain, are not to be reckoned as mountain chains, though like the tells on the Syrian steppes and dunes in the Netherlands and along the Baltic coast, they sometimes rise to the height of a thousand feet. In South Germany and in the neighborhood of lofty mountains, such elevations are called mere hills; at the north foot of the Alps, yet greater heights are almost always called level land. In judging of the fitness with which the word mountain is used, it must always be remembered whether he who employs it dwells among the Himalayas or on the lowlands of eastern Europe; and in order to give any fixedness to the use of the word, it is necessary to take into account other physical characteristics besides height. By common usage, however, the Alps have become the standard of comparison for all the mountains of the world, mainly because, besides having their imposing height, they are found in the middle of the temperate zone; they are the most convenient to study of any great system on the globe. In respect to height, we divide these into four grades: the lowest from 2000 to 5000 feet above the sea; the next from 5000 to 8000; the next from 8000 to 10,000; and the highest from 10,000 on to the height of Mont Blanc.

Another standard might be found in the colossal Himalaya chain of Asia, and the Cordilleras of both Americas, which could easily be brought into unison with the Alpine chain of Switzerland.

The linear direction of a mountain chain, the axis of elevation as we might say, (so sharply hinted at in the very word mountain-chain,) brings out relations which vary not only according to the longitudinal direction itself, but to the lateral extent, the number of mountains, the situa-

tion, and the ramification of the chain. If the direction be a straight one, we can rightly speak of an axis of elevation. According to Humboldt's measurements, this axis in the Pyrenees is 230 miles in length; in the Alps, from Mont Blanc to the Hungarian frontier, 515 miles; the Ural Mountains, 550 to 2042 miles; the Scandinavian Mountains, 1100 miles; the Altai Mountains, 9900 miles; the Kuenlun, 1600 miles; the Thian-Shan, in Inner China, 1700 to 2150 miles; the Himalayas, 1600 miles; the Yablonoi Chrabet, 550 miles; the Aldan, 400 miles; the Ghauts, 760 miles; the Andes of South America, 4400 miles; and the whole Cordillera of North America, 9200 miles. There is often much doubt about the true beginning and ending of a mountain chain, and judgments differ according as they rest on the fact of elevation or on the geological traces of upheaval where they begin to be manifest. Geographers are not agreed, for example, whether the Ural Mountains continue as far north as Nova Zembla, and whether one or two chains in America are to be spoken of as traversing the plateau of Mexico.

If there are parallel ranges, it is correct to speak of a transverse axis, running at right angles with the main axis. There is, it is apparent, a marked difference between simple chains and the accumulated parallel chains, where breadth is a prominent element, as in the Vosges, the Black Forest Mountains, the Fichtel range, the Hartz, the Ardennes. The parallel rows form a mountain system. Yet all great chains are made up of smaller ones, of groups at least, and so are mountain systems. Often the grouping is seemingly irregular, a lawless aggregation, but only because our knowledge is incomplete, and the law of arrangement concealed from us. This law is traced in the very geological qualities of the chain, not in the later form. The

outer form is often very deceptive, the very convulsions which indicate the surer signs having served to obliterate what we should suppose the most prominent marks. The present of mountains must often be studied in the light of their past. Orography must be interpreted by geology. But the geological surveys of the earth are as yet very imperfect; the outer form has often to be accepted as the only guide. Orography and geology are two sciences which now go on hand in hand.

In the simple mountain chain it is easy to discriminate between the parts which make it up; the base is easily ascertainable and the ascent to the comb-like ridge is readily traced; the eye does not fail to see the relation between the special prominent heights and the chain from which they rise, and to trace the manner in which spurs and outlying mountains are connected with the main chain. Small isolated collections of mountains are especially valuable as elementary studies, for they always have a unity of their own. And all the greater and well-known chains are made up of smaller, simple chains, whose connection and mutual relations are, however, sometimes exceedingly difficult to trace. But the character of the whole is not sometimes ascertainable with this preliminary knowledge of the parts.

The true base of a mountain chain, the line of periphery, in consequence of the general unevenness of the adjacent country, must be ascertained by very exact measurements with the level. The geologist does not begin with this step, he strikes deeper, and seeks the place where the structure diverges from that of the more level land lying near; and, in the search after the basis of structure, he discovers the unity of the range from the foot to the summit. The whole geological district which has been up-

heaved into mountains, Leopold von Buch found to be generally ellipsoidal in form, the longer axis being far more prominent than the shorter one. The axis of most mountain chains is, then, the longer axis of an ellipsoid. The Swiss Alps display about a dozen such ellipsoids, of different characteristics, and arranged according to no perceptible law of harmony. Each is developed from its own base, as the trunk of a tree grows out of its root. These separate bases lie contiguously, but the peaks which shoot up are widely sundered. The forms of the mountain groups resulting from this are, of course, various. Some of them I will briefly characterize.

1. The longer axes of the subordinate chains may run in parallels, as in one portion of the Swiss Alps, the Jura, the Ural Mountains, the Mexican Cordilleras, and the Himalayas.

2. The chains may diverge or converge. The Alps diverge at the east, and the forks run northeast and southeast respectively; the Rocky Mountains, toward the Arctic regions, divide into from five to seven diverging chains. Converging ranges may come together at varying angles, and these can mass themselves into confused mountain knots, the summits of which soar to amazing heights, as the West and Middle Alps do around Mont Blanc. Alexander von Humboldt distinguishes five of these mountain knots in the Andes, Porco, Cuzco, Pasco, Assuay, and Los Pastos, whose construction, carefully studied, he considered, gives the key to the structure of the whole chain. Side chains often display this knotted form, as in Upper Peru around Lake Titicaca, the three branches of the Ural, at the Irmel Tau, the Himalaya, Kuenlun, and Hindoo Koosh chains, in upper Afghanistan, and the ranges of Swiss Alps, which converge around St. Gothard. Yet

the convolutions which these mountain chains make at their point of convergence are never regular, never mathematically exact, but to be measured in sections, and the traces of a linear direction to be carefully sought with the compass. The whole has, to the eye, a labyrinthine appearance, and the law of structure is only ascertained, with exactness, by the geological features, the direction of the strata, and the like. The geographer must call in the geologist to help him solve his problems.*

3. If from some high central point the mountain ranges radiate in the form of a star, they form a new variety of system called, for convenience, by the name "star-shaped." In volcanic mountains this configuration is common, as in Mont d'Or and in Auvergne. The southwestern Alps, known sometimes as the Sea Alps, the Ural at the Arctic Ocean, the Quito range of the Andes, are types of this form.

4. The ring-shaped system is in direct contrast with the last. It is found where mountain chains are arranged in a circle, inclosing a plateau of larger or smaller extent. There are two marked examples of this form in Europe: Bohemia and Transylvania. The ring of mountains around the former is made up of a number of ranges, which dovetail together at the ends, making a unit, but only a rude circle, speaking with mathematical exactness. The inclosed basin is only relatively a lowland; it is rigid with hills and low mountains, yet of such little importance,

* Not inappropriately has geology been called the Anatomy of mountain ranges. The more mountains are studied geologically, the more safe become the conclusions that are drawn from them. The smaller and more scattered ridges of central Europe have become the chief quarries for geological discovery, because of the rich variety which they afford to the student, and also because of their accessibility.

in comparison with the rim of peaks, that the common name, the "Bohemian Kettle," has begun to have an accredited significance, and is stronger than the more loosely-used word Basin. Transylvania, too, partakes of similar characteristics. Its border consists of a number of minor ranges, of varying heights, up to 1800 feet; and the central hollow, which is much more strongly marked by hilly land than Bohemia, lies 2200 feet above the Adriatic. The ring-shaped system is one of the rarest met of all. They are, however, observed in abundance on the moon.

5. Just as rare is the form where ranges intersect in the form of a cross, those running, for example, from north to south, meeting those running east and west. As an instance of this, Humboldt cites the confluence of the Himalaya, the Kuenlun, the Hindoo Koosh, and the Belor or Belurtagh Mountains. The belt between 35° and 40° N. lat. is remarkable for its gridiron-shaped mountain system, the points of conjunction being marked by knots of peaks of colossal height. The most remarkable one of these is the lofty Pamir Pass, between $37^{\circ} 30'$ and $40^{\circ} 5'$ N. lat., and 18,000 feet high, known, historically, from the sixth century, and described by Marco Polo, as well as by the ancient Greek historians. The Persians dwelling in the neighborhood term it the Roof of the World. Elsewhere the same feature is observable, though on a scale of less magnitude. So in the Altai range at Lake Yetzkoi, in the western Swiss Alps, and in the porphyritic chain of Room-Elee, known to the ancients as Rhodope, and now as the Despoto Dag. This gridiron-shape of some mountain systems seems to be the result of upheavals at different times, which necessarily occasions the most broken configuration at the point where a chain of more recent formation has been projected through one of older date.

The varying relations of length, breadth, direction, connection, and severance of mountain ranges give great diversity to them, and impart to every system a character of its own. To the features just indicated must be added vertical or precipitous descents, for the influences which they exert upon the possibility of man's constructing mountain roads, are very great. The extent of these sudden depressions, or, more exactly, the relation which the distance from the base to the pass bears to the distance from the base to the summit, gives a key to the uses of certain mountains as adjuncts of civilization, and shows how some ranges rather than others may become the abode of men, and produce marked effects on human culture and the world's history.

I have before alluded to the comb-like structure of most mountain chains. The resemblance is more striking than may appear; for not only do the peaks correspond in general uniformity of height with the teeth of the comb, but the equally uniform height of the passes from the base corresponds with the uniform thickness of the solid part of the comb. The relation, however, of the distance from the base to the passes, to the distance from the base to the peaks, is widely various. Humboldt has estimated it in a few leading chains as follows:—

Himalayas.		Andes.	
Height of chain,	25,000 ft.	Chimborazo,	21,000 ft.
“ pass,	15,000 “	Height of pass,	10,000 “
“ base,	1000 “ (Delhi.)	Base,	(Sea.)
Alps.		Pyrenees.	
Mont Blanc,	14,500 ft.	Maladetta,	10,722 ft.
Height of pass,	7200 “	Height of pass,	8000 “
“ base,	1200 “	“ base,	(Sea.)

In the Alps and Caucasus the relation of the height of

the pass to the height of the chain is as 1 to 2; in the Himalaya, Quito Cordillera, and Alleghany Mountains, as 1 to 1·8; in the Pyrenees and Cordillera of Bolivia, as 1 to 1·5. In the Alps, therefore, where the pass is only half as elevated as the chain, the communication is the most direct, and the least barrier is put to the purposes of man,—a fact of great import in relation to human culture. The Pyrenees are in direct contrast in this respect, the most unapproachable, the most sundering of mountains.

The position of mountain chains is a matter of the first importance in relation to the welfare of man, and the solution of many of the most important problems in history. Whether interior ranges like the Ural and the Atlas, or ranges connecting two seas like the Caucasus, or those like the Mexican Sierras, lying between two oceans, are most open to human approach and use, is a question which we will not here stop to consider; but it may be said that, whether situated in the relations just indicated, or whether they are meridional ranges like the Ural, the Scandinavian chain, the Alleghanies, or the great Cordillera of both Americas, which extends from the tropical world to both polar zones; or whether they run in the same direction with the parallels of latitude, turning one side to the colder north, and another side to the sunnier south; or whether they assume a diagonal direction like the Swiss Alps, from southwest to northeast, or like the Caucasus, from northwest to southeast, is a matter of the first importance to ascertain. Of not less consequence is it to discover whether the chain is the edge or rim of a plateau, and can have, therefore, only a one-sided development, like the Himalayas toward the south, or the Anti-Taurus toward the north, because the existence of a plateau on the reverse side dwarfs the slant distance, and

gives but a fractional part of what, without the plateau, would be open and clear.

As plateaus usually display this edge on both sides, the border has been aptly compared to a double ledge or rim, between the two sides of which the table-land lies, often tolerably high above the sea level. If these rims, like mountains, are not contiguous to the plateau; if they are separated from it by a valley of greater or less width and depth, running parallel with the edge, they form what Humboldt has called natural circumvallations. Of such the Altai range, on the north side of the Asiatic central plateau, is an example. The hollow between the range and the plateau just mentioned is partly filled with inland seas. The Caucasus may, in like manner, be regarded as the circumvallation of the American plateau, separate from it by the Koor and the Aras (ancient Araxes) rims. Yet in the Caucasus another modification occurs—a partial linking of the plateau with the range at the west extremity, by the connecting chain of the Moschic Mountains. In like manner the Pyrenees, in their eastern half, form a circumvallation around the north side of the Castilian plateau, separated from it by the basin of the Ebro, and forming a perfect ring around Upper Castile and the elevated province of Biscay.

In cases where a mountain chain rests upon a plateau, rising up in the very heart of it, its summits seem to be not high, although the basis, the true foot of the chain, may not be at the level of the plateau, but far lower, and such mountains may, therefore, be of great absolute height. The name superimposed mountains has been given to them. Such are the Kuenlun and the Thian-Shan ranges of Central Asia, the Guadarrama chain between Old and New Castile, and the Rocky Mountains in North America.

These superimposed ranges often run near to and parallel with the rim or edge of the plateau, and seem to give it more completeness and breadth.

The geologist employs the word "sutures" to designate such forms, because they serve to unite those parts of a plateau which are at different heights above the sea level. He regards the mountains as rising to fill enormous clefts which great convulsions have rent in the earth, and as passing up, while in their fluid state, to a height above the level of the plateau, and bridging over the abyss. In this way our mountains which rest on plateaus seem to have been formed, as indeed is indicated by their geological structure.

The smaller plateaus display analogies kindred to those seen in the larger superimposed mountain ranges. The extinguished volcanic group of Auvergne rests upon the central plateau of southern France, which, according to Remond, has an average elevation of 1000 feet. The now silent volcanic group of the northern Rhine broke through the moderately elevated gray-wacke formation of that locality, and is, therefore, a superimposed range.

Mountain chains which diverge from plateaus and their serrated rims seem, nevertheless, to have some relation to them, even though they cannot be considered continuations of them. The Lebanon chain, for instance, which turns away at a right angle from the Taurus range, and runs southward through Syria and Palestine; the Lutznetskia and the Alatau Mountains, mineral ranges running from the Altai northward to Tomsk; the Yablonoï and the Stanovoi Chrabet ranges running to the northeast; the still unknown or little known range of Farther India, traversing the whole peninsula of Malacca, come under this head.

Completely unlike the groups thus far considered, are the isolated mountain systems, with uniform slopes on all sides, and with a roof-like form, distinguishable to the base. The mountains of Europe are mostly of this class—the Ural, Carpathian, Scandinavian ranges, the Alps, Apennines, and, in part, the Pyrenees. They give rise to rivers, not on one side alone, as do the Himalayas and the Andes; they are rich in resources of all kinds for the student and the economist, and thus make up in part for their comparatively unimportant dimensions. Their double-sidedness gives them a large influence on civilization, since rivers flow from them in all directions; while from the Himalayas they only flow to the south, and from the Andes to the east.

Plateaus and mountains, different as they are in appearance and characteristics, yet constitute, in their mutual action and reaction, and in their forms of transition from the one to the other, the highland system of the globe. Their relations are inexhaustible as Nature herself. We cannot study them without profit; but we can never come to a perfect knowledge of them all.

The Relations of Plateau Systems.

Like mountain systems, plateaus are not to be estimated in respect to elevated and superficial area alone, but in respect to form and position as well.

The American plateaus are elongated from north to south, but are of disproportionate breadth from east to west. The Asiatic plateaus, on the contrary, are not only of great length, but also of great breadth. The Spanish plateau, that of the Atlas system, and that of Asia Minor have their length and breadth nearly equal.

The surface of plateaus is exceedingly varied. It some-

times assumes the aspect of elevated plains, sometimes of rolling land, sometimes of horizontal strata of naked rock, as in Patagonia and the western Sahara. In one place it displays sand-hills, as in parts of the Gobi Desert; in others barren steppes, as in portions of Persia. Sometimes we find a gradual ascent of minor plateaus or terraces; sometimes single mountains rising out of the plateaus, as does Demavend; sometimes we find a chain of colossal peaks emerging from the heart of a plateau, like Thian-Shan and Bogdo-Oola. Sometimes there are plateaus broken up into crags and patches of level ground, like Persia; sometimes plateaus with deep valleys or river basins, like the plateau of Yoorkistan and Gobi, including the River Tarim, and reaching its greatest depression at Lake Lop, or, like the plateau of Afghanistan, including the River Hirmend and Lake Zareh; again, we have plateaus traversed by water-courses which forced their way in times of flood, and leave in the rainless seasons the traces of the former violence. Such are some of the less elevated plateaus of France and Bavaria.

Especially important are the combinations and groupings of plateaus, as well as their relation to adjacent lowlands.

In Africa the plateau form embraces the larger southern half of the continent. Low plains are, on the contrary, the prevailing form in the north, broken, however, by the Sahara, and the high coast plateaus of the Atlas range, and of Barca.

In Asia there is a vast central plateau with gradual declivities toward the east, toward Yoorkistan and Persia on the west, and toward Lakes Baikal and Zaisan on the north. On the south the descent is abrupt to the Indian lowlands.

In Europe there are, for the most part, scattered and disconnected plateaus of small size and little elevation, often passing by an imperceptible gradation to the other forms. The Spanish plateau is, however, a marked exception, and has the sharply-defined character of the northern African plateaus. In eastern Europe the central situation of the isolated Valdai plateau, whose elevation is very moderate, but 840 to 1080 feet, is remarkable, and is of very great influence in determining the hydrographical character of the great Russian lowlands. And in fact, the hydrographical influence of both mountains and plateaus is so great, that it is worthy of careful and special study.

The combining and grouping of plateaus in different continents give rise to great contrasts, observable most distinctly in Asia and America.

Asia, with all its great internal depression from Cashgar to Lake Lop, yet displays such immense districts of plateaus, all ranges of elevation, low, moderate, and very great, that the very grandeur and extent of its colossal mountain chains are subordinate in comparison. Asia is the land pre-eminently of plateaus.

America displays, not in its central but on its western coast, the greatest chain of mountains on the globe, flanked by plateaus of great elevation, but of superficial area quite out of proportion to the length of the mountain chain, and to the extent of the lowlands of both the northern and the southern divisions. And while in Africa the regions of depression are in the north, and in Asia around the great central plateau system, in the Americas, both North and South, they are thrown into the eastern portion.

Australia, in perfect contrast again, is, with the excep-

tion of its southeastern corner, a vast tract of unbroken lowland. No diversity is possible there, no change in the condition of life, but a ceaseless uniformity of monotonous but prodigal gifts.

Is not the imposing grandeur of these harmonious, provisional arrangements for the use of man calculated to fill the soul with admiring wonder, and to lead us to suspect, above all this display of cause and effect, above all this working out of a manifestly preconceived plan, the existence of a great and active BEING, who has planned and executed it all with higher ends and a loftier purpose than to satisfy the mere earthly life of man?

Primeval Formation of Plateaus and Mountains.

To enter upon a discussion of the manner in which plateaus and mountains were formed, would make it necessary to resort to such judgments as we could draw from their external appearance and their internal structure. The rapid progress of geology does indeed afford us many probabilities thoroughly grounded. A few of these may have been briefly indicated in connection with some elevated regions, where the massiveness is striking, and where the axis of elevation is prolonged to a considerable extent. In such cases the influence exerted on the world is more evident than it could be elsewhere.

Origin of Plateaus.

Alexander von Humboldt has employed the term *Intumescence*, to indicate the manner in which plateaus have been upheaved. Plateaus appear as long, often wide, mostly level, sometimes rolling, sometimes hilly elevations, presenting an appearance as if the earth had swelled with confined gases, and with depressions here and there as if,

in the casting of the molten mass within, a natural external subsidence had followed. They have, therefore, viewed in their internal structure, an unbroken wholeness, and are free from those vast fissures which characterize mountains, rending the earth for hundreds of feet down. The utmost want of uniformity is seen in the gradual depressions which often harbor the large internal lakes found in great plateaus. Varied as they are in configuration, they always retain marks enough to indicate that they owe their upheaval to steady, gentle, and not tumultuous forces within, exerted at the time of the primeval cooling of the earth's crust; in contrast, therefore, with mountains, which were thrust up from beneath, through huge seams made by the bursting through of pent-up vapor and gases. These elevations of the earth's crust, whether in the form of mountain or plateau, must correspond, in order that the symmetry of the globe may be preserved, to the depressions found in lowlands and beneath the water of oceans and seas.

It is observable that the great plateau upheaval of the Old World has taken the shape of a belt, which runs in a northeasterly direction along its whole southeastern shore, crossing the equator at an angle of 45° , broken, however, at some places, but never so much as to destroy the coherence of the belt. The diagonal of the rhomboidal plateau of eastern Asia, passing due northeast through the tableland of Thibet, indicates the direction of the whole band of highlands. This band drops toward the south in uniformly steep declivities; while toward the north it falls away with gradual steps of transition, reaching at length the regions of the greatest depression—Libya, northern Arabia, the Caspian, Siberia, and, at last, the low regions around the north pole

In this belt or chaplet of plateaus lie the high tablelands of South and Northeast Africa, Abyssinia, South Arabia, Persia, Beloochistan, North Deccan, Afghanistan, Thibet, East Tangut, and eastern Gobi, in Mantchooria.

Correspondent with this immense plateau belt, in the New World, is the great American chain, once a wholly volcanic, and though differing so much in structure, direction, and hydrographical influence, yet giving the globe a wholeness, a unity in diversity, which is strikingly apparent.

The Origin of Mountains.

The linear regions of elevations of the earth's surface, as we may term them, in contradistinction to the plateaus which are characterized by breadth rather than by length, have been projected in the form of mountain chains, as has been already hinted, through huge fissures made by the rending of the earth's crust. The upheaval to fill the seam has, in some cases, been all made at once; in others, in a succession of periods. The uniform agreement of all the geological strata or their diversity decides this point. Sometimes the rocky strata are laid bare and easily investigated. Often, however, the observer is obliged to draw conclusions from a part to the whole. Yet in all cases the mountain, in contradistinction to the adjacent plateau, is the tract which has been thrust through the crust. The frequent steep and lofty precipices show the immensity of the internal force required to lift the mountains from their places, while the lines of stratification indicate the direction of upheaval. The rifting of a seam in the earth's crust was the first step in the formation of mountains; the filling up of the seam by liquid matter, the second step. The upheaval of Asia, from the Persian plateau to Gobi, in a line 60° N. E., seems to be con-

nected with the most ancient revolution which the earth's crust ever experienced. The mountains there are, therefore, more modern in origin than the plateau on which they stand. The direction of the chain, in all cases, seems to have been dependent on the direction of the fissure in the earth's crust, which the mountain range afterward fills. The breaking through the crust necessarily occurred when the pressure beneath the surface was very great, or when a moderate pressure was exerted beneath a thin crust, where the resistance was slight.

The latter case seems to have been prevalent in most plateau regions. Their own gradual upheaval probably thinned the surface, and made it more liable to fracture. This accounts for the fact that the greatest mountains of the globe are found contiguous to plateaus. And the broader the original seam in the crust was, the broader the mountain range which rose to fill it, either at a single upheaval, or in a series of convulsive throes projecting successive masses of molten matter from below. In the latter cases the strata thus formed lie on each other like the leaves of a book, their constitution changing according as the more advanced stages of melting in the vast internal caldron throw out more metamorphosed rocks. These later layers rose to a greater or less height on the sides of the partially-formed mountain, according to their specific gravity, their more or less fluid state, and their rapidity of cooling, as we can now see by examining the layers in their present permanent condition.

Thus far we can conjecture, with great security, taught by the manifestly wild and fierce convulsions which once threw up the mountains, since in them distortion is the rule and regularity of structure the exception, and also by the equally manifest quiet and sustained process of up-

heaval, when the plateaus were formed; their strata being in a state of regularity and unbroken repose.

When the great vents produced by the outward pressure of internal volcanic forces occurred beneath the sea, they were filled up in the same manner as on the dry land, excepting that the summits of the mountains emerge above the surface in the form of isolated islands, or when there was a chain or group of mountains upheaved, as an archipelago. When there was no rifting of the surface, and no forcing up of whole chains of peaks through a thinned crust, the fierce action of the internal heat appears to have necessitated the upheaval of solitary volcanoes here and there, in some cases even rows of them, to give vent to the pent-up steam and gases, and to convey away the molten tide within. When such volcanic series rose in parallel ranges, they lifted, or may have lifted up the whole district between them, as if upon their shoulders, and so formed the American type of plateaus, of less breadth and greater length than the Asiatic, and in height corresponding with the volcanic peaks which form their rim, and to which they are probably indebted for the form of their structure.

It needs hardly to be added to what has been said above, that the general direction of existing mountain chains depends upon the direction of the primitive seams made in the earth's surface by internal forces. The Ural Mountains, the Scandinavian chain, the Alleghanies, the Ghauts, run on meridian lines; others more or less transversely.

The various kinds of rock which have been thrown up in mountains enlighten us as to the process and results of the internal heat of the earth; the successive formations display not only the various eruptions of molten matter, and

its discharge in new layers above what had been thrown out before, but reveal the relative age of the various formations. We have in a single chain sometimes a whole volume of history, marking off the epochs of upheaval with the most perfect legibility and exactness. Many crystallized rocks result evidently from the gradual process of cooling after the ancient exposure to the intense heat of the inner portions of the earth—granite, porphyry, gneiss, slates, and the so-called metamorphosed rocks. These used to be considered the oldest formations, but the upheaval theory treats them as the latest formed.

Most mountain chains have been uplifted to their present height by a succession of upheavals. To accomplish this has been labor of uncounted thousands of years. Only a very few—the main Carpathian range, for instance—seem to have been upheaved at a single convulsion, and to have assumed their present appearance at once. Where there were incessant eruptions accompanied with flames, and masses of molten matter (lava) have been ejected from the crest or from single summits, these volcanoes and volcanic ranges have been the result. Elsewhere no such phenomena have been visible. Possibly, in such cases, the masses cooled so rapidly as to extinguish or fill up what may have been embryo craters, and the plutonic acclivities may have been repressed, leaving us the traces of primeval eruptions, but no vestiges of any dangerous forces remaining till now. Of mountains formed in this manner, may be mentioned the Puys de Dome, the Bohemian basaltic peaks, trachyte Transylvania Alps, the Katak Kaumene, ("Burnt Tract,") of Asia Minor, and Hauran, Iceland, parts of the great American chain, parts of the Sunda chain, the South Sea Islands, and Bagdoola, and its range of extinct volcanoes in the Thian-Shan chain.

But other forces besides fire were competent to form mountains and plateaus, to spread layers of clay and sand and various deposits at the bottom of the sea, afterward to harden into strata of rock. In contradistinction to plutonic formations, these have been called neptunic, because formed at the bottom of the sea. The oldest of the neptunic or stratified rocks have been upheaved by the subterranean forces, and now are found in the elevated plateaus or mountain ranges, still having, however, their unbroken irregularity of structure. Also, after the stratification has been complete, and plutonic activities have opened the seams in the earth of which I have already spoken, and molten masses have rushed up to fill them, fragments of the primitive stratified rocks have been caught up and raised, together with the molten masses, to the very summits of lofty mountains; so that the geologist finds fossils there more or less perfectly preserved, the stratified rocks which contain them surrounded by the plutonic rock upheaved from below the surface. Chalk layers full of mollusca and infusoria have been found by Humboldt and von Buch on the very summits of the Andes, and corresponding with those which have been discovered by Ehrenburg in the deposits at the bottom of the sea.

Other older and more recent oceanic deposits are found in their primitive condition at the bottom of the sea, or in very low places on the land. In such localities the surface of the earth is composed of horizontal or slightly inclined layers or strata, of secondary formation, and whose origin in deposits from water cannot be denied. These are the beds of chalk, clay, sand, marl, gypsum, and other common substances; and these strata again have been overlaid with more recent accumulations, the result of di-

luvium or alluvium, continuing even up to the present time.*

Lowlands.

This variety of the earth's surface stands in the strongest contrast with mountain regions, or, in one word, with the highland form in all its modifications. The name lowland we apply to all those broad tracts which do not rise more than four hundred feet above the level of the sea. The absolute elevation is determined from a section drawn vertically from the superior surface to the plane of the sea. Every comparison by numbers of one lowland plain with its more elevated surroundings gives only a relative result, as for instance, in comparing the valleys of one chain of mountains with those of a more lofty chain. Such relative lowlands may lie at a great elevation above the sea, as the vale of Chamouni, for example, at the north foot of Mont Blanc, is 3000 feet above the ocean level. Both conceptions of the word lowland, which is common to elevated plains as well as those at the sea's margin, are entirely different, and should be kept distinct, although they are very often confounded.

* In exact correspondence with the historic progress of upheaval is the internal and external aspect of the result. In direct connection with the extent, course, grandeur, succession of oceanic and volcanic forces, and in constructing new geological formations, is the inexhaustible variety of structure, in respect to continuity, degrees of fracture, as well as the more or less rich prodigality of mineral treasure brought to light. The later formations—the masses injected to fill up huge chasms opened by volcanic pressure from below—are easily distinguished from the primitive formation. These courses are usually the depositories of minerals, which the great internal heat has apparently sublimated and crystallized, giving us our gold-sand, rock-salt, and the precious metals.

We are to deal here only with the absolute, great, and generally diffused lowlands, in contrast with which the elevated valleys and plains just referred to may be considered as mountain table-lands and the rims of plateaus.

We assume, as we did in judging of the two grades of plateaus, an arbitrary standard of measurement, and limit the rise of real lowlands to an altitude of 500 feet above the level of the sea. Great tracts of running plain, rising by so slight a grade as to be almost imperceptible, can be regarded only relatively as lowland, and, in a strict sense, belong to those regions of transition which fall more truly within the domain of highland or plateau. The word plain indicates the opposite of hill or mountain, but has nothing to do with the greater or less degree of absolute elevation, although it is often used as if it had.

The lower limits of lowlands are sharply defined enough. They are the margin of the sea, toward which the slope usually becomes almost imperceptibly small. Often the expression is used, yet not quite fitly, that the lowland extends into the sea for some distance, and is found beneath the surface. Strictly this is the bottom of the sea, and does not fall under consideration in this connection.

Many lowland plains rise so slightly above the sea level, that they are not unfrequently submerged, and, in many cases, owe their existence to repeated overflows. They are the basins of old gulfs, as in the very slightly elevated plains of Caracas, whose whole shore is open to the influences of the great Atlantic current flowing from east to west; or, as in the great Lombardy plain, which slopes at the same almost imperceptible degree toward the Adriatic. There are also some lowlands found in the interior of continents, and these, too, sinking below the level of the sea; but they are altogether exceptional, and only met with in

two or three instances. They are called, by an accommodation of an algebraic term, *negative* lowlands. To them belong the region around the Caspian and the Aral Seas, and the much smaller tract comprising the Dead Sea, and forming the Jordan valley; besides, there is the Suez steppe, inclosing the bitter lakes between Asia and Africa; and possibly the Beled-el-Jereed, in the western part of the Sahara and the central part of Australia.

To these it might not be incorrect to join those partial lowlands which have been rescued by human efforts from the sea; the marshes, for instance, behind the dikes of Holland, Sleswick, East Friesland, and at the mouths of the Vistula, the Weser, the Nile, the Ganges, and other rivers.

The most extensive lowlands in the world are probably those which embrace Siberia, in Asia, and the Canadian and polar region of North America. Many great tracts, entirely inland, are in those flat districts covered by seawater which was once driven in by great storms, and now lies stagnant, resulting in inapproachable swamps and morasses. Yet, under the equator, there are immense lowlands, as, for instance, in the eastern Sahara, although this region is broken by strips of plateau, and is by no means that uniform lowland plain which it used to be regarded. Northern Australia belongs to the same category, and also those immense plains which reach from the Atlantic so far into the interior of Brazil, along the lower Amazon. By the time, however, that they reach the middle course of that river, they have acquired, though in such imperceptible steps, a considerable degree of elevation, according to Humboldt's barometrical observations, and not reckoning certain limestone hills found there, from 1050 to 1200 feet. The plains of the middle Marañon are, therefore, true

plains, but not absolute lowlands, and not to be identified with the great flat region at the mouth of the river, and in comparison with the real lowlands of Venezuela, which do not rise over 200 feet above the sea, and genuine plateau, which, level as it is and broad as it is, is far more elevated than the Valdai plateau, in Russia.

Almost all great river mouths are true lowlands—the Egyptian delta, the delta of the Ganges and the Indus, for instance, (the two latter being separated by the very moderate plateau (100 feet) between Delhi and Mooltan;) to these we may add the delta of the Euphrates, the east shore of China, between the Blue and the Yellow Rivers, and Senegambia, between the Senegal and the Gambia. And in America, the same thing occurs in the Mississippi, Orinoco, Amazon, and La Plata, where the immense mass of water which they send to the sea passes through lowlands of very great extent. In the Mississippi they extend from the mouth as far north as the confluence of the Missouri and the Mississippi, where stands St. Louis, not 500 feet above the level of the sea. The prairies west of the lower course of the river rise rapidly, though imperceptibly to the eye, to the high terraces of Kansas, at Council Grove, varying from 1500 to 2000 feet absolute elevation, and then more rapidly toward the west, to mountain plains or plateaus, from 3000 to 6000 feet high. These, of course, lose the distinctive character of lowland.

The mouth of the St. Lawrence is, in some respects, analogous. Lowlands accompany it for a great distance from the sea; at Lake Ontario the elevation is only 232 feet, at Lake Erie only 565 feet. Yet the level tract is narrowed down to a mere border, and does not widen into great lowland plains. The contracted region of low

country along the St. Lawrence is broken up, too, by rocky heights and rib-like ledges, whose absolute height, however, is not to be confounded with the elevation of the plain which they traverse.

In entire contrast are the broad plains of South America, which lie along the course of the Orinoco, La Plata, and Amazon, the so-called pampas and savannas, which extend a great distance into the interior, farther, indeed, than investigators have yet thoroughly prosecuted their researches. In no continent are the distinctions between highland and lowland so sharply drawn as in America. The lowland plains occupy four-fifths of all the country east of the Andes, in South America: only one-fifth is highland; for, notwithstanding the extent of low plateaus and diminutive mountains scattered through these great plains, yet their entire amount is inconsiderable, compared with the immense lowland tracts of that continent. America has fitly been called the region of the greatest depression on the globe, because this is the prevailing characteristic of its whole eastern side, lowlands forming two-thirds of all America, and highlands only one-third.

In Asia, the later hypsometrical observations have shown that the lowlands are by no means so extensive as they were formerly supposed. The highland extends, according to von Middendorf, much farther northeast of the Yenisei, toward the northern limit of Siberia and Tschatschi, than was formerly supposed; and the Siberian plain extending westward to the Ural Mountains is narrowed down from 4,079,970 to 2,233,800 square miles. Yet this lowland comprises, including central Bokhara or Toorkistan, 1,051,200 square miles, and other low Asiatic plains 1,314,000, the enormous area of 4,599,000, or more than

twice the extent of Europe, leaving 9,636,000 square miles for the highlands.

In Africa there are almost no lowlands to speak of, excepting the districts around the mouths of the great rivers indicated a few pages back. To all equatorial Africa this physical feature is entirely wanting. In the north, where the whole Sahara was formerly thought to be one vast low plain, there are now known to be the moderate plateaus already indicated. The area of true lowland is, therefore, sensibly diminished. Vogel's barometrical observations have already shown us that the country around Lake Tchad is about 1200 feet above the sea; the surface of Lake Tchad is 850 feet above the ocean level, and the lower limit of that region does not, therefore, come within the range already set as the point where lowlands become highlands.

In Australia the lowland seems to be the prevailing physical form, although here and there exceptions to it occur.

In Europe there are three great lowland plains to be specially mentioned. The greatest, that of middle Europe, embraces the shores of the North Sea and the Baltic far inland, and extend the farthest to the southeast. A second, hardly of less extensive proportions, comprises all northern Russia as far as the White Sea and the Arctic. It embraces but one-third of the great polar plain, and is really one with the region beyond the Ural chain. The third is the region around the Black and Caspian Seas.

The Middle European Lowlands.

The Germanic-Sarmatia-Russian plain extends, without a break, from the mouths of the Rhine, through all central Europe, to the middle Volga and the Ural. It is pre-emi-

nently a region of lowlands, without any elevations of importance, and having no change of level, except very gently undulating swells, and on the north and south margin plateaus which very seldom rise over 500 feet. It begins with the deltas of the Rhine and the Scheldt, in Holland, passes through Lower Westphalia, Lower Saxony, the Marks, Lower Silesia, Lower Galicia, and Poland, as far as the upper Dnieper and the middle Volga. It extends up the Rhine as far as Strasbourg, 474 feet above the sea, up the Weser as far as Cassel, 486 feet, and up the Elbe as far as Dresden, 280 feet.

The true Rhine delta may be defined as lying between Amsterdam, on the sea, and Dusseldorf, 107 feet above the sea level. Then passing by the broken and romantic tract lying between Dusseldorf or Cologne and Mayence, we come to the true Rhenish lowland, 240 feet above the sea. Munster is 400 feet above the ocean level. East of the Weser is the Lüneburg Heath, which advances in elevation, as we go toward the Elbe and the Havel, to 300 or 400 feet. Brunswick lies at an altitude of 200 feet; Magdeburg, of 128 feet. The height gradually increases; at Wittenburg it reaches 204 feet; at Dresden 280 feet, where the Elbe issues from the highlands; and in Lower Silesia we find Breslau, 375 feet above the sea, and its observatory, standing on the hills around the city, at a height of 453 feet, which seems to be the highest point in the whole vast tract.

Between the Rhine delta and the now dry basin of Paderborn, from the Ems to the Weser, Aller, and middle Elbe, is the mountain tract of the Hartz, (with the Brocken at the north, 3500 feet high,) running up as far as $52\frac{1}{2}^{\circ}$ N. lat. By this natural feature the breadth of the great plain is considerably curtailed. As it is also more to

the east of the Leipsic basin, from which the Mulde, Elbe, and Elster flow, by the hill country of Lausatia and North Silesia, with the Riesengeberge, (Giant Mountains,) 5000 feet high, which extends northward as far as 51° N. lat.

A third basin is in the Silesian, from which the Oder flows toward the northwest, and enters the southern limits of the great plain near Oppeln and Brieg. A third tract of hill country lies on the east bank of the Oder, and extends to the middle Vistula, the Tarnowitz Heights, in Upper Silesia, about 1000 feet in altitude. The plateau north of the Carpathian range, on which Cracow lies, is 669 feet above the sea; and the most northern hill group of Kielce, between the Pilica and the Vistula, rises in the Kreutzberg to a height of 1920 feet, and in St. Catherine to 2000 feet.

The great lowland advances eastward, with always diminishing breadth from north to south, over the extensive plains of the middle Vistula, at Warsaw, 330 feet above the sea; over the Lithuanian morasses of the Bug; over the Sarmatian district of Minsk and Pinsk as far as Kiev, on the middle Dnieper, at the southeast, and as far as Orsha and Smolensk, at the northeast. Pinsk, in the middle of this tract, lies about 400 feet above the sea. The north side of the plain is bounded by the very moderate plateau south of the Valdai hills, at Smolensk, 792 feet high; at Osmana, southeast of Minsk, 882 feet. On the south side it is bounded by the equally moderate plateau of Wolhynia and Podolia, whose absolute altitude is yet undetermined, but which, at the source of the Bug, is about 1000 feet.

This is the great Lithuan-Sarmatian plain, which, east of the Dnieper, is transformed into the central Russian lowland, at whose middle point is Moscow, whose exact

elevation above the sea is between 300 and 400 feet; at Kazan, on the Volga, the height above the ocean level is but 270 feet, measuring from the highest point on the banks. Southward, the plain reaches to Simbeersk, 181 feet in altitude. The maximum breadth of this whole vast lowland tract is about 500 miles; the distance between Smolensk and Kiev, and the distance from the central point of the great Russian section to any sea, is between 500 and 600 miles.

The Origin of the Great Central European Plain.

The slight elevation of the lowland just described, rising but very little above the sea level, bears, throughout the most of its extent between the dunes of the north and the hill chains of the south, the character of a formation rescued from the domain of the sea within the very latest geological periods. The almost unbroken uniformity of the surface from the Scheldt to the Volga, about 2500 miles, confirms the character which its geological structure indicates. The deposition of disconnected, superimposed layers, running to a great depth, is exactly similar to that which we know results from the action now going on at the bottom of shallow seas. And in the great central European plain there is no sharply-defined geological limit met at the border of the North and the Baltic Seas. The same features extend beneath the surface of both of those seas. This whole lowland is, therefore, to be regarded as an immense basin, now dry, but once the bottom of a great sea,—an extension of the seas which now form a part of its northern border. The old coasts are now seen far inland. Wherever this coast-line changed its course, the whole landscape now alters its appearance; and yet more striking than the external view is the internal constitution

of the soil. Masses of stone, standing out in full view, reveal the inner structure of what lies concealed. And these rocky projections are precisely analogous to the jagged outlines of our present bold sea-shores. The land is not cut up by inlets hollowed out by the action of waves and currents to a considerable depth, yet traces of such movements, and of the physical formations effected by them, are found. Promontories and islands are now found in plateaus, and hills encompassing dry basins. To the latter belong the intervale of the Rhine, and the basins of Paderborn, Leipsic, and Silesia. To the former belong the hills and plateaus of Middle Germany; of the Westphalian Mark, from Elberfeld to Dortmund, or, as might be said, from the Ruhr to the Lippe; the Yeutoburg Forest to the Weser; then the Weser Mountains, and the Hartz to the middle Elbe; the Thuringian Forest and the Ertz Mountains around the Leipsic basin to the upper Elbe; the Lausatian Mountains and the Riesengeberge to the Glatz Mountains, on the upper Oder; the Trebnitz Heights of Silesia, and the lower plateaus of the Fore Carpathian range, embracing Cracow as far as the hills of Kielce and the confluence of the Sau with the Vistula. Along the southern border of the ever-broadening plain are the plateaus of Gallicia, about 1000 feet in height, of Wolhynia and Podolia, and then less elevated plateaus, till we reach the Dnieper.

The geological character of the border of the sea which once covered what is now central Europe, is full of interest, because from it can be deduced all that we can know of the history of those great changes.* But we must pass

* See Fr. Hoffman's Uebersicht der orographischen und geognostischen Verhältnisse des nordwestlichen Deutschland. Introduction.

over this, and only indicate the geographical configuration of the dry basin as it exists now, and forms the great Germanic-Sarmatia-Russian plain.

In the course of previous remarks on the lowest range of plateaus, I have remarked, that along the south coast of the Baltic the moderately elevated hill chains of Pomerania and of Old Prussia separated the true coast with its lowland from the great interior plain, forming a barrier, averaging about 300 feet in height, with here and there a form which runs hard upon the lower limit of plateaus of the second class; at any rate, a transition from between the lowland and the plateau.

It may here be remarked that the long, low chains, made up mainly of loose sand and other mixed and uncombined materials, and running along the southern border of that long, low band which skirts the Baltic, seem to be dunes once running along the shore of a sea which has now receded many miles to the north. In the deep channels and old inlets now dry, as for instance in the great break through which the Vistula passes below Thorn, only loose breccia, and no united layers of stone, appear. Yet this does not seem to be the case everywhere, although in the Cis-Ural and Baltic depressions dune-like ridges are to be found, some of them rising to a height much greater than was formerly suspected. These, it is true, are scattered, and only partially prevalent, but here and there they ascend to an altitude of nearly 1000 feet. At the eastern end of the great Pomeranian sea-plain west of Dantzic, and between that city and Bütow, where the sand ridge, which formed the ancient shore-line, runs very far to the north, there are a number of villages 400 feet above the sea. The Lower Mountain, (Thurmberg,) $54^{\circ} 13' 29''$ N. lat., rises to a height of 1024 feet; the hill near Upper Buschkau, east

of the Thurmberg, is 814 feet high; the hill near Hulterfeld, 846 feet; and the Höckerberg, near Schönberg, 902 feet.

Of the Thurmberg, Humboldt remarks that it is the most remarkable elevation between the Hartz and the Ural Mountains, and that but a few points in the Valdai range can be brought into comparison with it. Its position close by the sea is especially noteworthy. It is very probable, according to Humboldt's opinion, that those inequalities of surface, formed of sand once partly or wholly submerged,—found in Mecklenberg, Pomerania, East Prussia Proper,—and now divided into flats and hill ranges, do not belong to the dune system of the ancient shore-line, but have the reason of their existence in ordinary upheaval; in the formation of limestone, and of the usual Jurassic rocks, which, afterward, have been covered with sand and other loose materials. The peculiar accumulation of genuine marine fossils indicates the existence of upheaved rocks below the upper layer of sand.

It is these elevations which in the constantly advancing ridge or ridges run northeasterly, and take the form of plateaus, increasing in breadth from the water-shed north of Smolensk, and the source of the Dnieper, in the Valdai Forest, and the western Uwalli, and which are found between the Volga and the Dwina, and thence run eastward as far as Perm, on the Kama. They form the line of demarkation between the great Central European plain and the North Russian lowland, which extends as far up as the Arctic. This easterly chain, so far as it has been measured, seems to be less in altitude than the Valdai hills, which are about 1000 feet high. In East Prussia Proper and Livonia there are elevations of more than 600 feet; about 55 miles south of Dorpat Munnamäggi, the

point of culmination, according to Struve, is 996 feet above the sea; south of Vilna the heights of Puzewitch reach an elevation of 990 feet.

In the same direction, still northeast, runs the Valdai, forming the source of a number of large streams and the great water-shed of eastern Europe. On the road from St. Petersburg to Moscow, Humboldt found the altitude at Norwaja Ijetza 660 feet, and the highest point at Popowa Gora 792 feet, (according to Pausner, 876 feet.) One point going south from the Valdai, at Mosti Derewna, the latter naturalist has ascertained to be 1032 feet above the sea; and the highest point in the range is, according to Helmersen, 1098 feet. Still further eastward, between the Valdai hills and the lake region between Lake Seligher and Bielo Ozero, the range of uplands, known as Uwalli, running northwesterly, intersected by numerous canals, and forming the water-shed of a number of rivers, gradually diminishes in height, but, still advancing eastward, it rises again, in the neighborhood of Perm and the Kama, to 1014 feet,—about the elevation of the Valdai range. Uwalli is only the Slavie name of such hills as those whose absolute height is insignificant, but which, crossing as they do the great plains of Poland, Lithuania, and Russia, were formerly confounded with mountain ranges, and were so represented on the maps. They have, of course, great hydrographical value, and play a leading part as the water-shed of eastern Europe.

The Ponto-Caspian Plain, the Great Depression of the Old World.

This second vast lowland is the direct continuation of the central European lowland, with a decided sinking toward the Black and the Caspian Seas, indicated by the

course of the rivers of that region. It extends from the mouth of the Danube over the lower Dniester, Bog, Dnieper, Don, and Volga, as far eastward as the Sea of Aral. To the last named the Siberian plain gradually declines. The southern plain of Europe stands in unbroken connection, so far as its formation is concerned, with the West Siberian plain, (2,213,400 square miles in extent,) and is, therefore, one of the most extensive lowlands on the globe. The Baltic-Sarmatian plain is separated from the West Siberian merely by the long Ural chain, (from 50° to 67° N. lat.,) whose elevation is only from 4000 to 5000 feet, and whose breadth is unimportant. Take away the Ural, and a continuous line could be drawn from Breda, near the confluence of the Meuse, Rhine, and Scheldt, across Europe and Asia, following the line of 50° N. lat. as far as the Chinese frontier, passing over a continuous series of low, insignificant hills, heathlands, and steppes, and traversing a space estimated by Humboldt to be three times the length of the Amazon!

Toward the south, the Cis-Ural, European side of the Ponto-Caspian lowland, is separated from the Black Sea by a ridge of granite knolls, which passes from Volhynia and Podolia eastward as far as the cataracts of the Dnieper, and thence southeast, with diminished breadth, reaching its limit at Taganrog, on the lower Don, and the Sea of Azof. This ridge separates the narrow steppes of the northern shore of the Black Sea from the lowland of South Russia, the fruitful district of Ukraine. The height of these hills in the west, where they appear to have the greatest elevation, has been estimated to be about 1000 feet above the sea. Toward the Dnieper they have not yet been carefully measured; but probably there they do not rise above 700 feet.

The small sand steppe south of these granite hills runs from the Crimea eastward as far as the North Caucasian steppe, between the Don, Volga, and the Caspian, and indeed may be traced to the northeast as far as the Bashkiric-Ural chain. Lakes of marked saltiness are found there: Elton, for instance, which lies 24 feet above the sea; while farther eastward they are found, as for example on the Kamysh and at Samara at a depression of —138 feet, 60 feet below the level of the Caspian Sea. Yet this lacks confirmation.

From this lowland, only a few elevations arise, and these of insignificant absolute height; yet, on account of the extreme uniformity of the whole country, they are objects of amazement to the whole steppe world. The Little Bogdo, south of Lake Elton, and yet farther south, Great Bogdo, 504 feet above the sea, according to Humboldt, and Mount Arsargar, 331 feet in absolute height, according to Murchison, are the only important hills. The Great Bogdo is composed of calcareous limestone and of sandstone, with rich deposits of salt.

The Kirgheeze steppe separates, by a plain of very moderate elevation, the north Siberian lowland from the Caspian-Ural depression. It was formerly supposed, and indeed represented on the map, that a mountain range passes through this district from the Ural chain to the Altai. The Kirgheeze steppe appears to range from 780 to 960 feet in elevation; while the Siberian plain is but 280 feet above the sea at Omsk, 192 feet at Tora, and 108 feet at Tobolsk. It has been considered by some that the Kirgheeze steppe, as well as the granite hills of southern Russia, belong to an undeveloped system of mountains, an early cooling having solidified them before reaching the elevation which they would have attained; and that they

partake of the direction which analogy would teach us such a chain would have, from northeast to southwest, parallel with the Carpathian and the Caucasus ranges.

The great depression of the Old World begins with the deepening of the Volga basin below Simbeersk; and at the place ($51\frac{3}{4}^{\circ}$ N. lat., near Orenboorg and Saratov) where it breaks through the last row of hills in the Obstshei-Syrtis, it commences a rapid descent toward the Caspian and the Aral Seas. This great concavity, on the confines of Europe and Asia, at the center of the greatest land-mass, and far removed from any ocean, is remarkable as having no parallel on the globe. Humboldt remarks that perhaps a similar phenomenon would be repeated at the interior of other continents, if the tertiary formation and the parts found by marine deposit did not exist. It would be profitable to follow out so weighty a thought, with the surface as it now is.

The Obstshei-Syrtis is the moderate range of hills which runs westward in two branches from the Bashkiric-Ural, at Orenboorg, the northern spur running by Uralsk and the Ural River; the southern by Samara, rising on the east shore of the Volga to a height of 600 feet, and ending at Sarepta.

Orenboorg, on the Obstshei-Syrtis, where it leaves the Ural chain, is 255 feet above the sea. Uralsk lies somewhat lower, being 234 feet above the sea. The surface of the Volga, where it breaks through the high banks of Saratov, is only 36 feet above the ocean level; while the western shore, above Saratov, is 562 feet in height. Farther down the river, Sarepta lies 30 feet below the sea level; and there is, therefore, between Saratov and Sarepta, a distance of about 180 miles, a fall of 66 feet. West of the Volga, and following the river, is the continuation of

the Obstshei-Syrtis, ranging in elevation from 562 feet down to 168 feet. At Sarepta, the low hills which thus far have skirted the Volga turn to the southwest, to the Manitsh steppe, sinking to an elevation of but 75 feet, and extending as far as the Sea of Azof. At Sarepta, too, the Volga turns from its normal southerly course, and strikes southeasterly across the Astracan steppe, entering the Caspian at the City of Astracan, 72 feet below the level of the sea. The level of the sea is 4 feet below the shore on which Astracan is built.

The old statements that the level of the Caspian is 300 feet below the ocean, rested solely on conjectures made by the naturalist Pallas. The influence of this great depression on the warmer climate of that region, the peculiar vegetation of the salt steppes, and the salt morasses which exist where the land is perfectly level, as well as the great beds of oyster-shells and other crustaceous remains, led him to the hypothesis that the whole neighboring district is the dry and deserted bed of a former sea, now shrunk to the comparatively insignificant dimensions of the Caspian. The broken line of bold bluffs which bounds the Obstshei-Syrtis on the south seemed to him to be the northern boundary of this inland sea, into which the Volga entered below the pass of Kamyschin and Saratov. Parrot and Engelhardt supposed that their barometrical elevations in 1811 confirmed Pallas' theory, that the Caspian lies 300 feet below the ocean. Many hypotheses were based upon their observations; but the whole were at length brought into discredit by Humboldt, who distrusted the accuracy of instruments made at that time. Nothing but a trigonometrical survey from Taganrog to Astracan could give conclusive results, and this was accomplished in 1837, under the auspices of the Russian government. The re-

sult proved that, so far from being 300 or 350 feet below the ocean, the Caspian is not 100 feet. Its depression, as already stated, is about 76 feet.

The level of the Aral Sea, which is evidently closely linked to the Caspian, has not yet been determined with absolute certainty. Barometrical observations were instituted for this end by the expedition under General Berg, which explored that region in the winter of 1826, but the cold was severe, and the results are questionable. The result of their investigations was, however, that the surface of the Aral lies 110 feet higher than that of the Caspian. This would make the Aral to be 34 feet above the sea level. More careful inquiries may, however, determine the level of the two seas to be the same; but at present we have to be content with the results of the expedition referred to, and accept its elevation as 34 feet above the level of the ocean.

Without, however, going into details respecting the Aral, the region around the Caspian and directly connected with it, which is below the ocean level, embraces an area of not less than 131,400 square miles. This survey extends from the Volga to the Ural River, thence to the Emba and the northernmost point of the Sea of Aral, and thence to the salt lakes of Aksakal-Barbi, lying to the northeast of this sea. The tracing of this line from the higher to the lower stages of depression gives clear indications, in the nature of the soil, of the existence of a great sea once occupying that whole tract.

Thus much for the configuration of the Caspian lowland. If to these 131,400 square miles be added the 153,000, or, according to Humboldt, 164,000 square miles of the Caspian itself, the entire depression embraces almost 318,000 square miles, and is greater than France,

greater than Germany, and only to be compared with the whole Austrian empire! If to this great region be added the district around the Aral, which sea alone covers nearly 25,000 square miles, and then to this the yet unmeasured surface covered by seas yet to the eastward, the entire region of depression is immensely increased. And then if to this be added the great Siberian plain, whose level is not greatly above the sea, the combined district would be at least once and a half as great as all Europe.

The Origin of the Ponto-Caspian Depression.

Thinking of the immense extent of this depressed region, whose entire surface occupies no inconsiderable fraction of the interior of the Old World, and whose greatest depth at the bottom of the Caspian is from 500 to 600 feet below the level of the ocean, and looking at it as a phenomenon wholly unique, the question arises: How would such a condition be possible, contradicting, as it seems, all analogies? The answer, could we reach it, would not fail to illustrate many recondite geological questions, and to be full of instruction.

Yet the time has not come when a full answer can be given to this inquiry. We have not yet learned the elementary conditions of this remarkable fact; there are innumerable investigations yet to be made, before we can feel perfectly certain that its reason is understood. Still, there have been some preparatory inquiries entered upon, and some preliminary steps taken toward reaching a conclusion, or, at least, toward assuming a reasonable hypothesis. We have already indicated our belief that this depression is connected with a ring of plateaus which have been upheaved around it, and which now inclose it and isolate it from the ocean.

The hollow has its greatest depth near the southern extremity of the Caspian, where it rises abruptly to the Persian plateau. There pass, in the form of a half circle, the loftiest mountains and plateaus of central Asia. On the west side the Caucasus rises, with its giant peaks of Kasbek and Elbrooz, 15,000 to 17,000 feet high, bearing all the marks of volcanic origin,—avalanches of solidified lava on the sides, a lake lying in the abyss of an extinct crater, and the like.

At the southwest, the Armenian plateau follows the course of the Aras from its mouth back to the huge dome of Ararat, 14,656 feet high. The entire geological appearance of that region—the old lava streams, the trachyte rocks—indicate with equal clearness, as in the Caucasus, the agency of volcanic forces in the upheaval of that district. Traces of this great power are also seen in the caldron-shaped hollows, and in the narrow and deep defiles, which are abundant in that region.

South of the Caspian, which in its southern part reaches a depth ranging as low as 420, 480, and 600 feet, and, according to Hanway, even 2700 feet, rise sharply from the sea the Persian Coast Mountains. The plateau of Teheran, 3400 feet in elevation, is directly beyond, from which rise the volcanic peaks of Demavend, 20,000 feet, and Euczan, 6600 feet high. The Coast chain embraces the Elboorz Mountains, uniformly more than 5000 feet high, but which, at Schemrum, northwest of Teheran, rise to a height of 8560 feet; at Churchurah, southwest of Demavend, to 7650 feet; at Nevo, southeast of Demavend, to 8540 feet; at Nejoster, in the Seriakush, east of Demavend, to 7200 feet; and which, above Asterabad, rise in the Shahkush and the Sundukkush to a height of 7270 feet, and almost everywhere display in their trachyte rocks

the traces of ancient volcanic activity. Still farther to the east, the chain which has girdled the Caspian sinks from the lofty height of the Northern Taurus to 1872 feet; in Meshed, 2628 feet; in Herat, an average elevation of 3400 to 4000 feet. But east of Herat it rises abruptly to the lofty plateaus of Bamian and Cabool, 7000 and 8000 feet high, and in the peaks of Colubeba 16,800 feet. The Hindoo Koosh, at Dsellalabad, rises to a height of 18,984 feet; the table-lands of the Bolor, at the Issikul, are at an elevation of 14,664 feet; while the gigantic Pameer is not yet measured, though its noted Pass is estimated at 18,000 feet above the sea.

At this point we reach almost the 40th degree of N. lat., whence northward the mountain ranges gradually decline in height, after throwing off eastward the great chain of Thian-Shan. From the sharp angle formed by the Hindoo Koosh and the Bolor, where the head-waters of the Gihon rise, that large but commercially unimportant river takes its way westward through the Bokharan table-land, falling so rapidly in its course to Bokhara that at the city its surface is but 1116 feet above the sea, then striking north-westerly to the Aral and Caspian. The course of that stream indicates, therefore, the direction and degree of the mountain slope toward the great depression east of the Caucasus and Armenia, north of the Persian highland, and west of the Hindoo Koosh and the Bolor systems.

The lower course of the Gihon, from Bokhara downward, is through masses of mud, sand, and gravel, and can very easily be conceived to have changed its course in the lapse of centuries, from the Caspian to the Aral, as the course of the Sihon seems also to have changed. The great Bokharan plain is covered in this part with a deposit of dried mud; it is a steppe formed evidently from a now

dry sea-basin, which, no less than the northern shores of the Caspian and the Aral, displays the traces of the oceanic character of entire regions.

Halley, the astronomer, made an attempt to solve the mysterious origin of this great sunken basin, and attributed it to the stroke of a first-class comet! Arago, instead of calling into the scene meteorological forces little known, contented himself, in his theory of its origin, with the forces which we know are active even now on the earth, the plutonic powers which are only half confined by the surface of the globe. No one, he says, will hesitate now to accept the upheaval theory, through which geology is able so clearly to indicate the forces and progress of structure of the soil and rocks. The upheaval of great masses in one place predisposes the depression of districts in their neighborhood, to make good the true relation of highland to lowland. And in this case a compensation may be found, according to Arago, for the great semicircle of mountains which passes around the southern margin of the Caspian basin, in the depression caused by the natural falling in of the adjacent region when the great mountains of western Asia were upheaved.

In longitudinal mountain chains the parallel ranges of valleys have a similar origin; in volcanic chains, which have been thrown up in a circular form, similar depressions have been found in the middle, although, it must be confessed, on a much smaller scale of dimensions than in the Caspian hollow. The same feature is observable in the upheavals, by Von Buch, as observed in the Island of Palma, one of the Canaries, or in the Val di Bove, near Etna. Such depressions would at once fill with water, if connected with the sea, as in the cup-shaped island Santorini, or remain land-locked, if they occur in the interior,

as in the case of Lake Laach, as the half-ring of mountains girding the lower portion of the Caspian seems to consist mainly of trachyte thrown up by volcanic agency: the analogy just drawn does not seem too remote. Yet the process of structure must have had other concomitant conditions to account for the vast reach northward of the Caspian depression. It is clear that any such volcanic convulsion as would throw up those vast mountain ranges at the south, must have affected largely the geological condition of all the adjacent region; the extent vertically of this effect would be best ascertained perhaps by deep boring. Unquestionably there was many a revolution in the upper portions of the earth's crust during the formation of the great Caspian hollow, before it assumed its present condition. From the agencies at work in connection with a great internal ocean, the upper soil, as we have it to-day, was formed.

The Aral and the Caspian Seas remain as the lowest places of that great depression, water being found in them, while elsewhere it has entirely disappeared by evaporation: leaving us broad, low plains, instead of that great ocean which once extended from Persia over all Siberia, and west of the Caspian to the Sea of Azof. A more thorough account, geographical as well as geological, cannot be given till after much more extended investigations have been made into the physical characteristics of this region than as yet have been prosecuted. It may be remarked here, that the waters of the Aral and Caspian are bitter and salt, but not so much as those of the ocean; the bottom is covered with slime and sand. The Aral has a depth ranging from 90 to 222 feet; the Caspian, beginning with its extensive shallows at the north, deepens toward the south, till, reaching the lower third, its depth is over 600 feet;

and thence southward it is no less deep, till it reaches the bold shore of Eusellis. From this lowest point the upheaval begins, which culminates in the great mountains on its southern border.

According to Humboldt's view, the great Caspian hollow embraces not only the basin of the sea, but a vast dry plain, extending northward as far as Saratov and the Obstshei-Syrtis; even Uralsk lies lower than the level of the Black Sea. The same physical feature, though on a less extended scale than here, is found in Holland, China, Lower Egypt, and Palestine. Subsequently to the emergence of the continents, long before the filling in of huge fissures by mountain chains, and during the continuance of those great convulsions which reach back into the remotest geological periods, the surface of the continents must have been subjected to frequent partial changes of level. The surface undulated probably in that same wave movement which is now observable, though in much less degree, in those earthquakes and upheavals which the whole western part of South America is experiencing even now.

The depressions which have assumed a permanent form since the convulsions which formed them, have gradually filled with deposited soil, and, were the naturalist able to lay bare the primitive rock, he would discover that it exists in the shape of great concavities, without a trace of that evenness which now characterizes the surface. Eichwald has made it probable, by his personal observations, that the upheaval of Ararat and of the Armenian plateau on which this trachyte mountain rests, has driven the Caspian Sea back east of the flat steppe of Karabagh and Mogan, on the lower Aras, to the neighborhood of Bakoo. The water of that sea formerly extended to the confluence

of the Bargashad, (called also Bergershat and Bergernet,) with the Aras, below Ireben. The traces of volcanic action there are decisively evident: the Caspian reached, before that action occurred, up what is now the valley of the Aras, as far as Ararat; and in many places south of Erivan—at Saliyan, in Shirwan, and elsewhere—salt beds of the most crystalline quality, forming whole mountains and whole belts of salt lakes at the confluence of the Aras and the Koor, demonstrate their formation in a former sea which once covered that region. The very recent upheaval of the Ural chain cannot fail also to have had an influence in contracting the dimensions of the Caspian hollow.

Only two kindred depressions to this remain to be spoken of, which, though of not so great superficial dimensions, are of yet greater depth—the depression of the Jordan Valley and the bitter salt lakes on the Isthmus of Suez. These we must consider before we pass from the contrasts between highlands and lowlands to the transitions between them.

The Depression of the Jordan Valley and of the Dead Sea.

The nearest relationship to the Caspian hollow, displayed by any similar feature, is found near the heart of the Old World, in the comparatively diminutive and isolated valley of the Jordan, including the Dead Sea, whose absolute depth below the level of the ocean has been determined only within the most recent period. Many former travelers had noticed, in the deep gulf which holds the Dead Sea, and especially at its north end, near Jericho, a much greater degree of heat than elsewhere in Palestine, and the existence of many plants and fruits which

they had met in the hotter climates of Arabia and India. The tree which yields the Mecca balsam flourishes in the oasis of Jericho; the product of the balsam of Palestine supplied the pin-money of Cleopatra. A number of German and English observers endeavored to solve the question of the depth of the Jordan basin—von Schubert, Russeger, von Wildenbruch, Moore, and Bake, later Symonds, and Lynch; de Berton and Russeger made the first barometrical observations at the Dead Sea, but they did not attempt to give more definite limits to their results than to assert that its surface is somewhere between 500 and 1100 feet beneath the ocean level.

Von Shubert's barometer did not suffice to determine this point, but he ascertained the surface of Lake Tiberias to be 535 feet below the surface of the Mediterranean. All barometrical measurements were unreliable at that depth; yet it could not be denied that the depression could not be an insignificant one. A measurement with the level made by Symonds, an Englishman, from Jaffa to the Dead Sea, in 1843, gave us our first sure results. The surface of the lake lies 1231 feet beneath the level of the Mediterranean at Jaffa. The subsequent expedition of the Americans—Lynch, Dale, and Anderson, in 1848—has given the following additional results:—

The surface of Lake Tiberias lies beneath the ocean level,	612 ft.
“ “ the Dead Sea “ “ “	1235 “

Soundings of the Dead Sea, made with the greatest care, determined the depth to be, according to Lynch, 1227 feet; according to Symonds, 1970 feet. The entire depression below the ocean level would be, then, by Lynch's measurement, $1235 + 1227 = 2462$ feet; according to Symonds', $1235 + 1970 = 3205$ feet. This is the

greatest known depression on the globe. Jerusalem lies 2449 feet above the ocean level. From the roofs of the city to the surface of the Dead Sea is, therefore, $2449 + 1235 = 3684$ feet; and the entire descent from the capital to the bottom of the Dead Sea is 4911 feet, if we adopt Lynch's measurement, and 5654, if we follow Symonds'.

The basin of the Dead Sea consists of two very different parts—the larger and deeper northern one, the smaller and shallow southern one; the two being separated by a sandy peninsula—*el Mesraa*—and connected by a narrow channel of insignificant depth. The northern basin seems to owe its present form to the unchanged primitive depression; the southern one to a partial upheaval at some later epoch. But in breadth they do not vary much one from the other; both have their larger axis coincident with the Jordan valley, which here widens a little, but which is still hemmed in here, as farther north, by the parallel ranges of mountains. The chain east of the sea appears to rise a thousand feet higher than the one west of it. The depths of the two basins are entirely unlike. The southern is nowhere more than 12 feet deep, and diminishes to 5 feet and less than this near the shores, so that the southern half of it is entirely unnavigable by craft of any size; and those who wish to land have to wade for a long distance through mud as deep as their ankles. The northern part, on the contrary, attains a uniform depth of more than 1000 feet, from the north to the south; in the northern third it is even 1227 feet; toward the west coast it shoals to between 600 and 800 feet, but is 500 feet deep hard-by the coast. There is but a very narrow rim of shallow water on the western side, and the navigation is, therefore, tolerably safe. On the eastern shore the coast is even bolder, and the descent to deep water immediate.

Close by the romantic mouth of the Arnon, embouching through rocks, the depth of the sea is about 1052 feet. So great a difference in the depth of the two basins seems to indicate a considerable diversity in the manner of their formation.

Volcanic activities have been felt in the Jordan valley up to the present time. They manifest themselves in various forms—deposits of salt, hot springs and naphtha springs, asphaltum beds, sulphur fumes, currents of heated air, clouds of smoke, and rumblings beneath the surface. The Jordan valley remained, from Lake Tiberias down, unfilled, as we should infer from analogy that it would be by the upheaval of a chain of volcanic mountains; or by the expansion of an internal lake or sea, the waters accumulating till at last they should acquire such volume as to break away and form new channels. In case the obstructions were too great, they would remain inland lakes. And such is the Dead Sea, its southern border being too high to allow it a free exit into the Red Sea.

Many other fissures or hollows on the surface of the continents would be regarded as lowlands, were they not filled with water. The bottoms of such lakes often sink suddenly to a great depth, while others are lagoon-like, or shallow seas of an entirely different hydrographical character. Internal lakes, regarded as isolated lowlands, merely filled with water, are an especially interesting theme of study; yet much remains to be investigated regarding their structure and historical formation. The Dead Sea has been regarded, up to this time, as the deepest of all such lakes. The greatest depth of the Caspian has not yet been fully ascertained; but if Hanway's soundings, 2700 feet, are to be relied on, it is very great. Lake Baikal, in its deepest part, between the two steep walls of

rock which rise high above the surface, has not yet been carefully sounded; but as its surface is 1500 feet above the sea, its bottom does not probably fall below the ocean level. The great chain of North American lakes, whose area embraces about 109,500 square miles, are surrounded by level country from 500 to 600 feet above the sea—a region which, in part, falls under the designation of plateaus of the lowest class, and which, in part, comes under the name of lowland; the surface of Lake Superior being 627 feet above the sea, Lakes Michigan and Huron 578 feet each, Lake Erie 565 feet, and Lake Ontario 232 feet. The three first named, having a depth of about 900 feet, have their beds about 300 feet below the surface of the ocean; Lake Ontario, with a depth of 500 feet, reaches a point 268 feet below the sea level. The depth of the St. Lawrence river bed, as related to the sea, is not ascertained. The most of the Swiss lakes, too, having a depth often of more than 1000 feet, come under the same category with the lakes under consideration above, waters from the mountains having gradually filled up chasms made at the time of the upheaval of the adjacent region. Some of these lake basins may be deep enough to lie below the level of the ocean.

The Bitter Lakes of the Suez Isthmus.

Some bitter salt lakes on the Isthmus of Suez, forming a chain from the Red Sea to the southeast corner of the Mediterranean, long claimed attention from their supposed singularity. During the occupation of Egypt by the French in 1799, a survey of the district was made with the level, in view of a prospective canal across the isthmus, connecting the Nile with the Red Sea. An account of that survey was published by Le Père, in his great

Déscription de l'Égypte. The result of the survey was very surprising; it assigned to the Gulf of Suez a height of 25 feet at ebb tide and $30\frac{1}{2}$ feet at flood tide, above the level of the Mediterranean, a result which seemed to agree with Pliny's account (vi. 23) of the elevation of the Red Sea above the level of lower Egypt. The salt swamps lying between the two seas, and known even to the ancients, lie, according to the same authority, 20 feet below the surface of the Mediterranean, and 50 feet below that of the Red Sea. These singular statements were not received without considerable doubt as to their correctness; but during the military disturbances in that region, no revision of the investigations could be made. Certain circumstances connected with an unusual inundation of the Nile in 1800, when its waters flowed as far as the transverse valley called the Wady Tumilet, in which the salt lakes lie, and where traces of the ancient canal, built by the Egyptians between the seas, could be seen, seemed to confirm the result of the survey of 1799. The inference was a natural one—that the sandy Isthmus of Suez was an accumulation of dunes, and of the deposits of inundations of both the Mediterranean and Red Seas, and that the salt morasses in the middle are but a trace of the primitive bottom. There were not wanting defenders of the old measurement, Favier being the most prominent. Since 1845 five surveys have been made, in reference to the projected canal. These all contradict the results of 1799, and show that there is but the difference of four-sevenths of a foot between the level of the two seas, and that there is the same agreement there as in all other parts of the earth. Many hypotheses, built on the old measurement, have accordingly fallen to the ground.

The Regions of Transition between Highlands and Lowlands; the River Systems of the Globe.

Between the two great and most sharply-marked physical features—the high plateaus and mountains and the lands of very little elevation—there are regions of transition very numerous and exceedingly varied.

The conception of highlands and of lowlands having a certain, constant, and absolute value, and it being immaterial whether the elevation be specially marked or not, provided it be uniform, the regions of transition find their most marked characteristics in their want of constancy, in their very change, and the rate at which the grade ascends from a low to a high elevation, or falls from a high to a low one. Their real value lies in the mutual compensation of highlands and lowlands, which is effected through the mediation of a third physical feature or system, which has received the name Lands of Gradation, or Terrace Lands, and which, by their gradual rise from the sea level, serve as the means of transition from the lowest lowlands to the loftiest plateaus and mountains.

Terrace Lands and Rivers in their General Character.

Districts sloping to the sea, or lands of gradation, as we have called them, varying as they do in elevation and in relative situation to each other, are the true mediators between the districts but little above the level of the sea and others much more lofty. At the sources and the mouths of rivers they partake, more or less fully, in the characteristics of both highland and lowland. The manner of their mediation, as determined by the rate of the fall of water and by their direction, gives to every one of these regions of transition its peculiar character, determines its

conformation and its relation to the globe. And yet, no more than in lowlands and highlands, can we rid ourselves of some arbitrary data relating to the size of rivers, when we discriminate between those which we call large and those which we call small. As in all other geographical distinctions, we must here be content with arbitrary approximation, and with the ordinary usages of speech. The comparison of streams, in regard to their breadth and fullness, determines their volume; the comparison, in respect of length and tributary waters, determines the compass of the river system. The entire characteristics, breadth, depth of channel, length and extent of drainage, determine the status of the river, whether first, second, or third class, in relation first to those of the same continent, and then to those of the world. The Volga, for instance, is, in relation to Europe, a first-class river, but, like the Danube, in relation to the entire globe, is merely in the second or third rank. Not the length alone determines the importance of rivers. The Thames, one of the smallest streams in Europe, is one of the most important. And aside from commercial considerations, a river of insignificant size can have great influence in consequence of its relation to the entire adjacent region. The little Bavarian Isar, a river which, so far as the great world is concerned, seems to have no importance, receives on the left side the water of 860 tributary brooks, among which are 44 rivulets; on the right bank the water of 433: these 1293 brooks and rivulets pour themselves into the Isar through 103 direct tributaries, and not these alone, but the waters of 136 lakes are embraced within the Isar system! Yet the Isar is only one of 34 branches of the Danube, and of the fourth rank even among them, and the Danube is by no means one of the great rivers of the globe. A short but

navigable stream can have great influence over a territory limited in extent, and may make a long but shallow stream sink into insignificance in respect of comparative importance to the world. There are some great streams which are of first magnitude in all their characteristics—rivers which drain millions of square miles in their course to the sea. The number of such is small, however; there are scarcely fifty on the whole globe. Besides these, there is a large number of rivers much shorter, and of much less volume, but not deficient in the attributes which give a stream value to man, and which serve to mediate between highlands and lowlands, to fulfill the needs of navigation and to drain regions of more or less magnitude. These can be classed in four ranks: in the first place absolutely, and in the second place in relation to each continent. Yet, in classing them, it is necessary always to keep in mind that it is not size alone which gives a river its value, but a combination of all its characteristics, and its relative influence on the country through which it runs.

Looking at the direction of streams, we observe that there are some which flow northerly, as for instance those of Siberia, the Nile, the Rhine, the Elbe, and the Weser; there are those which flow southward—the Indus, Ganges, Euphrates, La Plata, Mississippi, and Volga, for example; there are those flowing eastward—Hoang-ho and Yangtse-Kiang, the Amazon, the Orinoco, and the Danube, for instance; and some westward, instances of which may be found in the Gihon and Sihon, the Senegal, Gambia, Niger, the Colorado, the Seine, Loire, Garonne, and the Spanish rivers which enter the sea in Portugal.

And this characteristic, trite and unmeaning as it may at first seem, establishes, for the area which these rivers water, very diverse conditions. In like manner, too, their

position, in relation to the oceans into which they flow, is very influential, in consequence of the action of the tide upon the lower course. The emergence of their head-waters at various altitudes, whether on plateaus of the first or second class, or on mountain tops covered with perpetual snow, gives rise to a great diversity of relations, that makes no one stream on the earth twin brother to any other. Rivers have an individuality which claims recognition, although they are usually summed up in one category.

This diversity in rivers becomes more apparent from a study of the diversified form of the terraces, or grades of transition, through which they pass on their way to the sea.

The great basin of the Nile is divided into three distinct parts or grades—Abyssinia, Nubia, and Egypt; and each of them has long been studied historically and physically. The great basin of the Rhine is also naturally divided into three grades—the Swiss highlands, the German moderate plateau, and the lowlands of Holland. In a similar manner there may almost always be traced in rivers three natural grades, and where they do not have, as in the cases just cited they do have, a historical significance, their physical influence is not hard to trace and to follow into all its analogies.

The word water-shed, now a familiar one, is applied to that point of division where contiguous springs pour their water in different directions. It is not even in a mountainous country necessarily coincident with the highest points of the chain, though it may be; the valleys may slope in such a way as to have more influence in determining the direction of running water than the mountains hard by. Every stream has its own water-shed system, and this system is the real boundary of its basin. If we trace this

basin to its very limits on the highlands, we may find, not a mile away, the beginnings of another river, which shall flow in just the contrary direction, as for example in the case of the Rhine and Rhone, the Volga and the Dwina. The sources of the Missouri and of the Columbia lie close together, not a quarter of an hour's walk apart; yet the waters of one flow into the Atlantic, of the other into the Pacific, and their mouths are almost 2500 miles apart. The Mongolians hold the water-shed in such estimation that they throw up a heap of stones wherever one occurs, establish it a shrine for prayer; and the Toongooses of Siberia never pass by one without casting a cedar branch upon the stone heap, that, to use their expression, "the holy mountain that parts the waters may not lessen, but increase."

The main channel is the stream proper; the others are tributaries. The longest tributaries coming in from the region where the river proper rises, can be grouped intimately with the source of the main current, hardly distinguished from it in relative importance—the two, for instance, in the Nile, the five in the Indus, two in the Ganges, three in the Amazon, etc. All form in their confluence the real channel of the river. And the entire body of tributaries, taken in conjunction with the river proper, forms the river system, and the district which they all drain is their true reciprocal. The two, in their mutual action and reaction, form a whole, and are always thought of together. The source and the mouth are the beginning and the end of the whole system; the main channel and the circuit of water-shed, the center and the circumference of it. All the tributaries in their union constitute what may be called the arterial system of the river basin; the form of each and the characteristics of each are analogous to those

of the whole, only in reduced pattern. The network which all the tributaries make is often surprisingly intricate. The symmetry with which the main characteristics of a river system are carried into the details, even of its smallest accessories, can only be compared to that observable in the architectural regularity of a tree, as it expands from the main trunk into the countless symmetrical branches.

There are some rivers which are entirely independent of tributaries—which pursue their way to the sea entirely alone. Such rivers, however, never belong to the first class; they are always of subordinate magnitude, and the humblest of them are mere coast torrents, like those west of the Andes. Others find their way to no ocean, but lose themselves in an inland sea or lake, as the Volga does in the Caspian; as the Gihon and the Sihon do in the Aral; as the Jordan does in the Dead Sea. Others disappear in sand wastes or in morasses; such are the rivers of the African steppes. Others are blocked up, as it were, by the tidal wave of the ocean, and are thus converted into estuary lakes.

There are some rivers, also, which remain equally or nearly equally full the whole year through; there are others which have their seasons of overflow: the Nile, for instance, and many rivers whose basin lies within the region of tropical rains; there are temporary rivers, now full, now empty, which, if they do not leave, like the torrents of Arabia, a perfectly dry bed, are traced in the dry season by a row of stagnant lakes, such, for example, as are found in the swampy lands of Australia.

Rivers more closely considered.

What is peculiar to every river is determined by the abundance of its sources, the forking of its tributaries, the rate of its descent, the distance from its most remote springs to its mouth, the main direction of its course, and the greater or less sinuosities of its channel, as occasioned by the structure of the country which it traverses.

The abundance of its waters is conditioned by the greater or less amount of snow which finds the highest springs, the heavy rains which it receives in tropical countries, and the exceedingly varied influences which temperate climates may exert upon it. The fall softens from the rush and plunge of the mountain district, first to an arrowy swiftness, then to a moderate course, then to a beautiful gliding motion, to end with an almost imperceptible flow just before entering the sea.

The direction of rivers is determined :—

1. By the structure of the region which they traverse, the layers being in some places horizontal, and in others tilted to a vertical position; here grouped, as in the granite Carpathian chain, in such a way that the river courses which begin there run in parallel lines, radiating like the rays of a star from a central point; then grouped in such a manner that a stream may receive tributaries from two nearly contiguous ranges, as among the spurs of the Ural Mountains, the Rhone in Valais, receiving waters from the Bernese Alps at the north, and Pennine Alps at the south; the Isère, in like manner, the Upper Rhine in Grisons, the whole Upper Inn in Tyrol.

2. The direction is also determined by the mutual action of tributaries and the main stream at the point of confluence. Very often the union of two powerful currents

gives rise to a third direction, according to the law known as the parallelogram of the forces. This generally occurs when no obstacle stands in the way of their taking a normal course, and is exemplified in the cases of the Kama and Volga, the Theiss and Danube, the Rhine and Main, the Saone and Rhone. Where an obstacle stands in the way, their abnormal direction is manifested in the abrupt bendings of the river bed. An instance is found in the bending of the Rhone northward as it emerges from Valais. Its lower course, from Lake Geneva to Lyons, betrays the same angularities, resulting from the obstacles which it meets and cannot remove. The Rhine, breaking through the Jura at Basel, is another instance; the Rhine, between Bingen and Caub, and the Dal-Elf, in Sweden, also exemplify the same.

In case that rivers meet in their course large masses of stratified rocks, they force their way through them in a zigzag direction, making sharp angles always, and not unfrequently right angles, even. Instances of this are found in the Rhine, between Mayence and Coblentz, and in the Moselle, between Treves and Coblentz. When the river passes beyond these rocky barriers, and meets with obstructions of a more movable character, it crowds them more gently and gracefully aside, and leaves a path more sinuous and wave-like; and yet more gentle are its curves, as it opens a way through the plains where nothing obstructs its course. The last is strikingly exemplified in the rivers of eastern Europe, especially in all those of middle and southern Russia. The practised eye can determine the structure of the soil with considerable certainty, by merely tracing the course of rivers when represented on a faithful map. For, unless there be other reasons to prevent, rivers always force their way where

there is the least resistance to overcome. In stratified rocks, where the tilt is so great as to make the strata vertical, the river beds usually run parallel with the lines of stratification. Instances are found among the Alpine rocks, in Valais along the Rhone, in Tyrol along the Inn and Adige, in Grisons, and among the Jura along the Rhine. Where the lines of stratification are horizontal, rivers usually take their course through the most marked ravines and fissures.

In most mountains, however, the lines of stratification are neither vertical nor horizontal, but intermediate between them, more or less sloping, as in most marked ranges of central Germany, for example. In such cases, the process of excavating river beds has been determined by various circumstances and conditions, and the direction of their channels does not alone depend upon the extent and tilt of the strata, but also on other forces which have exercised a favoring or a retarding influence on their direct course. The stratification has its influence, indeed, but it is general rather than specific. Still, it is very largely felt when it happens to coincide in its main lines with the direction of the mountain range, but is comparatively insignificant when it does not. We have instances in the Alps where the axis of stratification coincides with that of the main chain, from south-southwest to north-northeast; in the Jura, from southwest to northeast; and in the Scandinavian range, from south to north.

The different geological formations found in mountain districts have a very important influence in determining the direction of rivers. Mountains do not generally consist of rocks of one kind of structure, but of several. What stratification is to mountains whose geological formation is the same throughout, the superposition of

different kinds of rocks is to those of composite materials. The layers may be divided into superior, inferior, and adjacent. These usually vary in respect to age, and may be traced in a regular geological seniority, as for example sandstone, gypsum, limestone, gray-wacke, and granite. These formations are either closely contiguous, or are separated merely by valleys, as for instance in the Carpathian chain, where the central granite knot is separated by valley plains from the more southern limestone chain; an example of contiguity is found on the west spur of the same Carpathian range. Wherever mountain systems of varied geological structure approach each other very closely, rivers seldom break their way through either one, but find their way along the roots of the mountains, till at last they come to a less confined place. Such river courses are often very large and deep; for the mountain streams which meet and are hemmed in by the narrow pass between the two contiguous ranges sweep all loose obstructions before them, and not only leave their path clear, but continually deepen it. We find this in the Ural, the Isère, the Rhone, Aar, Inn, in all the long and winding Alpine valleys, and in the Ebro, fed by the parallel ridges of the Pyrenees. The circle of rivers which girds the central Carpathian knot is an illustration of what was said a momentsince. The Poprad, Dunayic, Arva, and Waag are found where the true Carpathian chain, which is granitic, is closely contiguous to subordinate ranges of limestone and gray-wacke. In any accurate map, the long, winding course between these two chains may be easily traced. Looking at the point where the Hartz Mountains and the Thuringian ridge touch at their roots, the groups are seen to be insulated, as it were, by the rivers which gird their bases. In the great streams of southern and southwestern

Asia, too, the line of the water-courses can be traced along the narrow valleys which separate main from subordinate mountain chains; the Terek, Kooban, Koor, Aras, Euphrates, Tigris, Indus, Ganges, and probably the Chinese rivers, are all examples of this.

Some streams seem to be entirely independent of all these laws in forming their channels, and to have their direction assigned to them by the freaks of nature, such, for instance, as fissures in mountain chains and clefts, which remain to indicate ancient convulsions.

The entire course of a river is divided into three distinct and subordinate courses—the upper, middle, and lower. To these and their respective tributaries correspond the three grades of transition found on the banks, and which have already been alluded to. Not only the total amount of fall in the river bed, but also the angle of inclination, and the whole complex of phenomena in the basin, are reciprocal to the threefold character of transition in almost every hydrographical system in the world. Still, the variety of relations which arise from the combination of different elements is so variable, that an almost infinite diversity arises in the characteristics of rivers, and these characteristics always vary, too, according as found in the upper, middle, or lower course.

Upper Course of Rivers.

This begins at the ridge of the water-shed, and extends to the limits where the river emerges from the most rocky highlands. It depends for its existence upon the greater fall in the river bed there than lower down. At the upper course, therefore, rivers which may flow in exactly opposite directions are brought into direct neighborhood. The farther they advance from the water-shed the more they re-

cede from each other. In the High Forest south of the Carpathian chain, and in the Bory Morass north of it, the waters which flow into the Baltic and into the Black Seas spring from the ground side by side. The name given to the districts where the head-waters of large and navigable rivers part is usually the French word *portages*, the English word *transports* being little used in that connection, although all, the German *Trageplatze* and the Russian *Wolok*, involve the idea of *carrying*, of portage, from the head-waters of one stream to those of another. The lowest parts of a water-shed, the passes of a high mountain range, for example, the intermediate vales of lower ones, and the most elevated plains in flat districts, are the most suitable for the purpose of canal building, to serve as a connecting link between the sources of divergent streams; as, for instance, the canal which is proposed to connect the Baltic and the Black Seas by uniting the Vistula and Danube, the tributaries, the Poprad, Hernad, and Theiss being the channel of communication up to the mountains where a canal is to pass over the water-shed formed by the valleys of the Carpathian chain. Such a communication is the most available which can be made between the opposite sides of a mountain range. The practicability of constructing such canals depends very largely upon the degree of fall in the upper course of the connected rivers, as determined by the slope of the bed toward the horizon. The grade of most mountains' sides, which stand back to back, is unlike on the two sides: steep on the one, slight on the other. Upon this depends the greater or less wildness of the streams flowing through their upper course. In the Ural chain the slope is steep on the eastern side, gradual on the western; in the Caucasus, steep on the north, gradual on the south; in the Carpa-

thian and the Alps, just the reverse—steep on the south, gradual on the north. The rate of fall varies; but, in general, it lies between an angle of 2° and an angle of 6° , taking the entire upper course into account. On the very steep north side of the Pyrenees, the fall is between 3° and 4° ; on the south side of the Alps, from the summits of Mont Rosa and Mont Blanc to the plains of Piedmont, it is $3\frac{3}{4}^{\circ}$. It is far less in more unimportant ranges. And this angle, it should be remarked, is an average; it is the resultant of a great number of special, short slopes, which vary from the perpendicularity of an occasional waterfall to the equally occasional tranquillity of a meadow-like flow. The incidental slopes are, of course, much greater than the average of all. A grade of 15° is very steep; it is the maximum that can be ascended by a beast of burden. A grade of 8° is the maximum for wheeled vehicles; all roads must be less sloping than this. To accomplish the ascent of 35° , a man on foot must have some assistance. A grade of 44° in the high peaks of Mexico and Peru, Humboldt found inaccessible; only where the growth of trees and shrubs gave him an opportunity of planting his feet, could he climb where it was a little steeper than 44° . The Carpathians and the Pyrenees, on account of their steepness and their scanty verdure, are very difficult to ascend. The Alps are much more easily climbed than the mountains just mentioned, in consequence of their abundant growth of turf and undergrowth. The richest Alpine meadows of Switzerland have an inclination not exceeding 20° ; at a greater slope the vegetation becomes more sparse. The grade on which it is possible for earth to cling, Lehman fixes at 45° , and considers that the normal slope, because at a greater angle, rain glances or ricochets. But Lehman is not right in

assigning this as the normal slope possible for earth to cling and vegetation to grow, for on the Alps soil adheres and plants get a footing at a much steeper angle than 45° ; in fact, the modifications in the appearance of the Alps, by the growth of trees clinging to steeper slopes than this, are very marked. From the highest possible grade where vegetation can get a footing, we advance to the sheer perpendicular.

The upper course of rivers is characterized rather by plunges than by equable flowing, and determines its way by a series of leaps through zigzag cuts and various ravines. It traverses bowl-shaped hollows and narrow defiles, and makes its way even through mountain lakes, depositing in them its residuum of sand and gravel which it has caught up and swept along. In its wild plunges it draws into its body considerable air, which appears as bubbles, and makes it a white mass of foam. By-and-by it reaches more level ground, becomes clear as crystal, and assumes a rich emerald green, or a deep blue. It is unnavigable, wild, romantic, and is always found in mountain districts.

The brawling brooks of Salzburg, of the Pyrenees, and of Sweden and Norway, all partake of this character. Those of the Pyrenees have a fall of an inch in every foot, and in some places cataracts of two or three feet. The same is observable in the Alps, where the continual stir of the water mixes in air enough to turn all into a mass of silvery-white foam. The Carpathian waters are the same before they reach the high plateaus lying at their feet. The Alpine lakes, too, which lie within the upper course of the rivers which feed them, have a considerable fall; Lago Maggiore, for instance, has a descent of 52 feet between Magadino and Arona.

In all the most marked mountain systems of Europe, the upper course of the rivers is especially prominent. Northern Europe is characterized by the fact that its streams have, throughout the most of their length, the peculiarities of the upper course—whether observed in northern Russia, in all Sweden, Norway, and Scotland.

With the exit of the river from the mountain district, all these relations are changed, and a new character begins.

The Middle Course.

Far more moderate is the descent after the river emerges from the mountain region, or where it has never experienced the wild turbulence of the upper course, as is the case in most of the rivers of eastern Europe. In the middle course the angle of inclination is much modified. The upper Main has a fall of 342 feet within three miles after leaving Fichtel Mountains. The descent of most of the rivers of central Germany is much less than this. The Neckar, whose sources lie 2084 feet above the sea, in passing to Heilbronn, which is 450 feet above the sea, falls at the rate of about an inch to every 32 feet. The fall of the Saale, after leaving the Fichtel range, is about 20 feet to the mile; that of Naab, about 14; that of the Eger, less; and that of the upper Oder, in Silesia, still less. More gradual yet is the slope of the Volga bed, which falls but 1400 in about 2050 miles, considerably less than a foot to a mile; and in its lower course its inclination must be still less.

The effects of the current must necessarily be very different from those observable under the influence of the dashing and wayward upper course.

The name River Bed is given to the entire breadth of the hollow which holds the river, and which varies in

width according to the stage of the water, especially in large streams like the great rivers of America. The Mississippi is a mile wide at Natchez at low water, at high water almost thirty. The Orinoco, at St. Thomas, is three miles wide at low water, at high water it is over seventy. In the Volga and the Danube the stage of water makes great differences in the width of the river bed. In summer the depth and breadth are, as a rule, less than in winter.

The Channel differs from the river bed; it is the part of the river bed which gives life and motion to the whole current. In the upper course the channel and the river bed generally coincide; in the middle and lower courses, on the contrary, the channel occupies but a very small share of the whole bed, but yet it determines the direction, amount of fall, and the rapidity of the stream. It lies usually not in the middle of the river bed, but on one side; it passes, however, from bank to bank; it is indicated by the movement of ships, which always follow it, and it lies uniformly adjacent to the boldest shore. It widens the whole river bed toward one side, and not toward both; and so streams which traverse great plains, like the great Hungarian one, for instance, do not now run through the middle, but course along at the base of the marginal bluffs. In all such cases, it will be found that the channel hugs the boldest side of the bed. All the four Carpathian rivers, as they wind out between the main range and the subordinate ranges, have their steepest shore, not on the side of the loftiest, but on the side of the boldest mountains, and these are the ones of the subordinate range. So, in the plains which lie between the Swiss Alps and the Jura, the bold sides of the river bed lie on the side of the bolder though less important chain, and not on the side of the Alpine meadows. The

bold banks of the Ebro are not on the side of the Pyrenees and their plains, but on the south side. All the streams of South and Middle Russia have, therefore, on the east side, their low banks, on the west the bold ones; and this, because the most extensive plains lie on the eastern side.

In the more level tracts the windings of rivers are very much increased in magnitude. These windings check the current. The serpentine course is characteristic of rivers in their middle course, and it is repeated, though on a small scale, in every meadow brook. The serpentine course of rivers gives rise to countless islands and intervals: as, for example, between Bâle and the Rhinegau, but, with very few exceptions, no lakes, the characteristic feature of the upper course of rivers. But the broad meadow lands of the middle course very often indicate in the clearest manner that they were once lakes of considerable magnitude, which have subsided and left their basin a dry plain. An example may be found in the meadow land of the Rhine, from Bâle to Bastberg, below Strasbourg, and again from Ladenburg, in the Palatinate, to Bingen. So on the Danube, from Ulm to Passau, Lintz, and Kloster Newburg, and again from Pesth to Beloro Semlin, as far, in fact, as the narrows at Orsova. The same feature is met in the middle course of the Volga, from Tver eastward to the west Ural, and southward to Saratov and Kamishin, where it breaks through the Obstshei-Syrtis, which was, doubtless, once the barrier of a great inland lake. In these basins, now dry, there is a surprising uniformity of characteristics wherever on the globe they occur. They differ but little, whether found in the middle course of the Ganges, the Indus, the Euphrates, or the American rivers. The still, incomplete stream of

the St. Lawrence shows us, even in the present, what the ancient conditions were before they solved the problem of their complete development. There, a row of such lakes as formerly existed in the now fruitful plains of the middle Rhine, the middle Danube, and central Russia, are the five great Canadian lakes. They still constitute the middle course of the river, and one pours itself directly into another, either over a gentle slope of land, or in a great cataract and rapids, such as we do not observe in the middle course of other streams, which are not, like the St. Lawrence, incomplete. Only when waterfalls disappear can the inclination of rivers become a gradual one. The uniformity of the grade of their channel is, therefore, a sign that they have attained to a complete development. In such, slight rapids remain, instead of the ancient cataracts. The existence of those primeval falls we find in all rivers, even in the Rhine and Danube. The rounded faces of the rocks which once were the barriers to the rivers' course, and the debris once swept down from the mountains and deposited over the bottom of the ancient lakes, show this.

The strongest instance of cataracts, resembling the ancient ones which connected the lakes of nearly all the great rivers of the globe, is seen in the fall of Niagara. That cataract is an epitome of the falls of all other streams. The Niagara River conducts the water of Lake Erie, by a channel 33 miles long, to Lake Ontario, 300 feet below it. At the Great Fall the river plunges about 150 feet into a chasm which it has hollowed out from the soft stone between the two lakes. The cataract was formerly seven miles below its present location, and has been observed to be steadily working backward since its discovery. In the distant future it will, doubtless, wholly disappear, as

all others have done. For the Niagara is merely a striking instance of a principle once universal, but which merely worked itself out on a smaller scale. The more fragments of rock and mountain debris were swept along, the sooner were the primitive falls rent away by the wash and the percussion, and the development of the middle course completed.

The places of transition which lie between the higher dry basins and the lower ones are still to be traced in almost all rivers; not by great waterfalls, which belong only to the upper course, but by simple rapids. They are more or less characterized by narrows, with steep, rocky banks, where, doubtless, cataracts existed in the primitive times. They are recognizable by this feature, that they are uniformly alike, and distribute their force equally on both sides of the river. Examples may be found on both sides of the Rhine, in the narrows between Bingen and Bacharach; on the Elbe, from Tetshen to Shandau, Dresden, and Meissen. In these places the rivers have a very tortuous course, and there are whirls and rapids (*rapides*, *sauts*, of the French; *saltos*, *randales*, of the Spanish; *schewerin* of the Russians) which impede navigation. In these localities the entire aspect of nature is changed, and the landscape becomes exceedingly beautiful. Here we find ancient narrow roadways; here are places of great historic interest, and of great interest to the naturalist, assuredly not of accidental origin, but in close connection with the development of the river bed, and in close analogy with all places of transition from highland to lowland.

We may, perhaps, mark these features in all the rivers of the earth. A knowledge of them is essential to understand thoroughly the natural development of a river sys-

tem in its true parts; unfortunately, they have as yet been too little observed and described. Among European rivers they are found in the Guadiana, at the Saltos de Lobo; in the Douro, at the rapids below Torre de Moncorvo; in the Ebro, at Sastago, below Saragossa; in the Rhone, the rapids below Lyons, between the granite banks of Pierre Encise; in Loire, by Iguerando, below Roanne; in the Rhine, below Strasbourg, and at the narrows at Bingen, near St. Goar and Andernach; in the Weser, at the Porta Westphalica; in the Danube, at Grein, at Kloster Newburg, and at Yachtali, Drenir Kapi, (Iron Gate,) and Orsova; and in the Dnieper, the thirteen waterfalls below Yekaterinslav. The same features are repeated in all the other streams of Europe and the remaining continents. More close investigation of them will lead to important results, concerning the structure of the earth in the regions intermediate between plateaus and lowlands.

As a high grade, great cataracts, sharp and bold cliffs, and mountain lakes characterize the upper course of streams, so rapids, dry lake basins, and a meandering channel characterize their middle course. Below the lowest rapids are found the level plains or lowlands which give rivers their third characteristic.

Lower Course.

As soon as the rivers break through the lowest range of hills which once beset their course, they deposit the debris which they bear with them, and begin the formation of diluvial plains. We find in the soil of all level places along the middle, as well as the lower course of rivers, traces of the same kinds of rock and minerals, which characterize the mountains where they rise. The rate of fall in the lower course of rivers is so slight as to

be almost imperceptible. Relatively, it is the greatest in the Volga; from Kamishin to the Caspian the descent is more than 150 feet, although the distance is less than 500 miles. The Senegal, from Podor to the sea, a distance of about 200 miles, falls only about $2\frac{1}{2}$ feet; the Amazon, within about the same distance, falls only $10\frac{1}{2}$ feet, or about an inch to the mile. In such rivers, therefore, the tide can flow a very long way inland.

This gives rise to a great conflict of forces—the pressure of the stream in its natural flow, heightened at the appropriate season by the annual inundation, and the backward pressure of the tidal wave. Before these forces come into equilibrium, the river bed is constantly changing. The river proper seeks this equilibrium by a parting of its channel, dividing into two mouths, as in the Nile, or into more than one, as in the Rhine and Danube, or several (about 65) in the Volga. The momentum of the stream, the resistance of the tide, and the consequent slow speed of the current promote the fall of deposits along the lower course of rivers. Below the surface the result of these deposits is found in sand banks or bars; above the surface, as low, marshy land, the deltas, subject to frequent inundation. We see this in the Rhine, the Nile, the Euphrates, the Indus, the Ganges, the Mississippi—in all, about fourteen of the first-class rivers of the globe. The contrary feature, single, broad mouths not yet filled up by alluvial deposits, negative deltas, or deep ocean inlets, can be observed in nine others of the largest rivers—the Obi, Yenisei, St. Lawrence, Columbia, La Plata—mostly found, however, in the north of the earth, where there is very little of the more loose and fruitful soil which more southern rivers bear onward from the mountains where they rise.

Another peculiarity of the lower course is seen in the extraordinary changes in the river bed—the shifting of the channel from one side to the other. This is the natural result of the very light and movable character of the deposits brought down from above, and the strong pressure of the current, which, though slow, has great momentum. In the lower course of the Ganges, Indus, Euphrates, Nile, Rhine, and Po, these changes can be traced as a matter of history, and, in the lapse of centuries, have had great influence on the formation of the great plains of those rivers' mouths and on the people living there. With the lower course begins the regular yearly inundations, which cover vast districts in tropical countries; and to these inundations may be attributed the gradual raising of the level of the plains covered by them. Hence arose Herodotus' descriptive phrase ποταμοὶ ἐργατικοί, (prolific rivers.) The great fruitfulness of these lowlands is well known. The rich alluvial deposits have made Bengal, Babylonia, Egypt, Lombardy, Holland, and the Netherlands the granaries of all neighboring countries.

In proportion as the mouth of great rivers resembles an inland sea, having a strongly marked tidal flow in sympathy with the ocean, does the whole nature of the lower course vary. The rivers whose mouths are turned to the east and south are those which are exposed to the strongest and the highest ocean waves. Such are Chinese, Indian, and South American rivers, which sometimes show the result of this, 500 miles inland. The tide extending so far into the interior facilitates navigation very much, and transforms the lowlands along their margin into districts, which seem transitional between true continent and oceanic islands. All the mouths of first-class rivers which open toward the north and west are less deeply affected

by the entrance of the sea waves. To these belong most of the European streams. Exceptional to both of these classes are the three rivers, the Nile, Danube, and Volga, whose direction is not toward the ocean, but toward the center of the Old World. They form a triad, not of oceanic, but of continental streams; in them there is no ebb and flood. Their lower course and mouths must, therefore, display different relations from those of any other of the great rivers of the globe.

It was early remarked that not all streams, when they reach the sea, flow at once into it, but come to a standstill. It is so with the Thames, and with most of the North American rivers. The ocean sometimes throws a tidal wave twenty to thirty feet high up their channel, and dams their flow. Rivers vary exceedingly in their relations to this high barrier. The Chinese streams are sometimes raised forty feet by it above their normal level. This gives rise to a salt oceanic river, so to speak. It is the same with the Thames at London. At high tide the surface is salt, while the water at the bottom is fresh. The struggle with the downward current and the upward current is very often visible. It is so in the Orinoco, the Ganges, in the Chinese rivers; most of all, in the St. Lawrence.

In all the continents there are many small rivers and rivulets which have no normal mouths; which lose themselves in the earth before they reach the sea. Sometimes they pursue a subterranean course, and emerge again, though usually with a changed name. Among the best-known of such instances is the Perte du Rhone, below Geneva, where the river flows for a little way directly beneath a spur of the Jura Mountains. In like manner, the Meuse, which loses itself in the earth at Bazoilles, in the Vosges

Mountains, west of Nancy, flows in a subterranean bed as far as Noncourt, nine miles distant, and then emerges. The phenomenon is common among the Jura, and in the limestone cliffs which feed the Drave and Save. The tourist meets almost hourly there some brook or little river disappearing beneath the ground. On the high Asiatic plateau of Gobi, 68 rivers are known, which disappear in a similar manner; in the north of Thibet there are 115 such. They are common, also, in the Chinese province of Yun-nan, on the Persian highland, and on the plateau of the Bechuanas, in South Africa. In South America, between the Andes and the La Plata, there are twelve lakes without effluents, the greatest being Lake Titicaca. In Central America, there is the Lake of Mexico.

The division of the whole length of a river into the three courses—the upper, middle, and lower—and the proportionate share which each of these bears to the whole, depends upon the height at which the source stands above the mouth. The greater or less extent of the transition grades, and the greater or less extent of navigable waters, also depend on the same. The upper course has, as a general rule, too many hinderances to be very valuable for navigation; it is, at best, adapted only to boats. The more united and deeper middle course offers facilities for vessels of considerable draught; yet the frequent sunken rocks and eddies and rapids are a great impediment to navigation. We find it so in the Rhine, below the Falls of Schaffhausen, as far as Bâle; and in its middle course, at Bingen and St. Goar; in the Danube, also, at Grein and Orsova.

The lower course, on the other hand, opens like a broad fresh-water sea, that sometimes allows large ships to sail 50, 200, and even 500 miles inland. These maritime

streams ought to be discriminated from others ; the Chinese call them "sons of the ocean."

The proportions in the length of the upper, middle, and lower course of rivers are exceedingly variable ; and equally variable of course are the transition lands apportioned to each, and forming its natural supplement. The upper course of the Volga is very short, the middle very long, and the lower very short. The same relative proportions, though with very different dimensions, are found in the Vistula, the Ganges, the Euphrates, and the Mississippi. The upper course of the Rhine, on the contrary, is very long, through all Switzerland to Bâle ; the middle also very long, to Cologne ; the lower, very short, to Rotterdam and the sea. It is the same with the Nile, the Danube, and the Indus. In the Marañon or Amazon the upper course is very short, the middle and lower very long. In the Chinese rivers Hoang-ho and Yang-tse-Kiang all the three courses are relatively long.

The length of the middle and lower courses, although important conditions of navigation, are not the only ones. Others are not to be overlooked,—the amount of water, depth of channel, and the like. These, however, are not capable of being generalized under any law, but depend upon the individual characteristics of each stream. Every river needs, for an exhaustive account of its features, its own monograph.

There remains but one important point to be considered—one which has exerted a very great influence on the diversity of structure in all river systems, controlling the area of their drainage, their volume of water, their effect on human culture, and on the ethnographic character of the people dwelling on their banks. It is the distance from the source to the mouth in direct distance compared

with that following the tortuous course of the stream. The two lines almost never coincide; they generally lie far apart. And the less they approach to coincidence, the greater becomes the area of the river basin; the more numerous and valuable the tributaries to the main course, the greater the volume of the stream and the more varied and extensive its influence.

One or two examples drawn from European rivers will more fully explain this point, to which Buache has already called attention in his "*Parallèle des fleuves*."

The mouth of the Volga is 982 miles distant from the source, in an air-line. The distance, including all the curves of the stream, is 2012 miles, the bendings adding 1028 miles to the direct course. By this doubling of the shortest possible distance, the area drained by it is swollen to the enormous size of 657,000 square miles. The direct course lies in a diagonal direction from northwest to southeast; but the real direction is a changing one. First, it flows a short distance from north to south, then in its middle course it has a double direction; first eastward, toward the Ural chain, then to the south, and lastly, in its lower course, to the southeast. Through this varied course it receives tributaries from very remote sources, and waters a country altogether greater than would be possible if the Volga's course were direct from the source to the mouth. Its basin becomes so large as to embrace a fifth of Europe, and the stream becomes one of the longest and most available for navigation in the continent. The vastness of the volume of water and the wandering course have both contributed to the value of the Volga lowlands.

The exact contrast to the Volga is found in the Dniester. In the Volga there is a maximum of windings; in the Dniester there is a minimum. The air-line distance of

the mouth of the Dniester from the source is 408 miles; the distance, including all the bends, is 450 miles; the loss in winding is, therefore, but about 42 miles. The theoretical course of the Dniester, *i.e.* measured by an air-line, would coincide very nearly with its actual course. There cannot be, therefore, any distant springs whose waters flow into its channel; its basin is one of the most contracted in the world in consequence of its directness; and a small belt, embracing but 32,850 square miles, comprehends the entire district that it drains, freed from all those tributaries which make the Volga basin so important.

The Dnieper, its eastern neighbor, is 630 miles in direct distance from the source to the mouth, but 1000 with all its windings; leaving 370 miles as the extraneous shore, which adds to the value of the basin, and contributes to the 219,000 square miles which it drains.

The same contrast is seen elsewhere, though not on so extended a scale. It is to be found in the Vistula, Oder, Elbe, Weser, Rhine, and Danube. These rivers give shape to the transition terraces between broad eastern Europe and the more contracted western portions of the continent; their dimensions are, therefore, on a less extensive scale than in the great Russian streams. Still, the differences in them are worthy of notice.

In the Vistula, the direct distance from the source to the mouth is 329 miles, and the real distance is 611 miles; the windings comprise, therefore, 280 miles, or about two-thirds of the air-line from extreme to extreme. It becomes able to receive a large number of tributaries, and its basin is enlarged to an area of 78,402 square miles, becoming one of the best-watered and most fruitful on the globe.

In the Oder, the direct distance from the source to the

mouth is about the same as in the Vistula. But while the latter frequently changes its course, running first northward, then eastward to the Sau, then northward again to the Bug, then westward to the Drewenz, and lastly northward, and so gains a very large basin of drainage, the former is unvarying in its course from southeast to northwest; so that the direct line drawn from extreme to extreme, as the bird flies, is nearly coincident with the actual course of the river. The windings do not, at most, comprise one-third of the whole length of the stream, and the basin drained by its tributaries is at least a third less than that of the Vistula, and is proportionately less valuable to the interests of the world.

In the Elbe the air-line length is 394 miles, greater therefore, than that of the Vistula or the Oder; its length, including its windings, is about the same as that of the Vistula. The area of its basin lies therefore between the two, 61,320 square miles; it is more valuable, therefore, than that of the Oder, and less valuable than that of the Vistula.

Still less striking in this respect are the Weser and the Ems; but the Rhine assumes a prominence, in relation to the value of its basin, greater than even the Vistula. The direct distance from the source of the Rhine to its mouth is 423 miles, the actual distance 705 miles; the windings comprise, therefore, more than two-thirds of the entire length of the stream. The number of tributaries is uncommonly large, the area drained is increased about 9855 miles beyond that of the Vistula; and the entire basin (88,257 square miles) is one which has been of the greatest import in the history of all central Europe.

All the rivers and all the terrace lands of the globe exhibit the same relation which we have been briefly indi-

cating in a few European ones; in some of the great rivers of the world they are to be traced on a scale of grandeur of which in those which have been touched upon scarcely a suggestion is given.

But not in this feature, added to what has been already said, do we exhaust the fruitful subject of Rivers, and the terrace systems which accompany them from their source to the sea. The diversity of phenomena traceable in them had hid their unity from geographers, and prevented their tracing general principles in so manifold details. The dry, linear representations on most of our maps have blinded the eye to the living and organic relations which river systems enter into, and through which they exert a great influence. They must be examined singly; they must be studied in their real character and individuality, and each must have its own monograph, before we can fully know the value of river systems to the world.

We have now to touch upon one or two points omitted, thus far, in our discussion of the hydrography of the continents.

The stream is a unit; most streams have a single channel as the last goal of their descent. Others may have double channels, which contend with each other for the superiority. If they are double only for a part of the whole length of the river, and in the upper or middle course flow together, and form one main channel, they can be called twin head-streams. We have an example in the Danube and Inn, which are equally long and equally large. Other instances are the Rhone and the Saone, the Volga and Kama, the Missouri and Mississippi, the Blue and White Nile, the Ganga and Jumna. Others have triple head-streams; as, for example, the Hither, Middle, and Farther Rhine; the Ucayale, Huallaga, and Marañon, which

combine in the middle course to form the Amazon. There may be even five head-streams, as in the Indus. Often it is only through the usage of speech, often through ancient and exploded errors, that the name of one of the head-streams is given to the whole river.

If the double channels continue through the whole length of the river system, they belong to a different category; they become true double systems, and have a double influence on the development of the whole range of terraces from source to base. From their meeting in a common bay or gulf at the mouth, they may be called sister-streams; and, from the territory which they inclose between them, the Mesopotamia, they may be called Mesopotamic streams. Between such double streams some of the greatest States of Asia lie. Universally known, on account of their influence on Asiatic culture, are the Euphrates and Tigris uniting in the Persian Gulf, Ganges and Brahmapootra uniting in the Bay of Bengal, Gihon and Sihon in the Sea of Aral, Hoang-ho and Yang-tse-Kiang encompassing the Central Flowery Country of the Chinese Empire, and meeting in a common delta. These double streams are mostly met in Asia, and they have exercised a great influence on the whole growth of oriental civilization.

In South America there is yet another and more complex form yet of river system. The Amazon is connected with the Orinoco by means of the little cross-river Cassiquiare. By this connection the middle course of both rivers is made more available to navigation than it would otherwise have been. Such cross-streams may be found, though on a smaller scale, in other continents; in Africa, for example, between the Senegal and the Rio Grande. There a network is made between the parallel rivers, but

it is available for navigation only in the wet seasons. In Central Africa there seems to be a similar phenomenon between the eastern tributaries of Lake Tchad and the western tributaries of the Bahr el Abiad or White Nile, though this rests on the authority of the Arabs. In India there appears to be a similar connection between the middle course of the Indus and the Jumna, and so the Ganges, by the mediation of the Sarasvati or Histara and the Gharghara. There may have been the same in Central China, between the Hoang-ho and the Kiang, where the Imperial Canal now runs; and a similar feature may be found in the Lithuanian marshes, connecting the Vistula and Dnieper river systems, through the mediation of the Bug and the Przypec. The skill of man has, in many places, accomplished the same end by the construction of canals.

Although all rivers, in the course of their development, follow the universal law which leads them from their source, however high, to the sea, yet there is, even in their descent, scope for exceedingly varied phenomena. It is not necessary that everywhere a strongly-marked line of water-shed should exist, but often, as in all the more level plateaus, there are broad, neutral plains which perform the function of water-sheds, though possessing no decisive character. It is so through a great part of Central Asia, in the low plains of Australia, probably in a large part of Africa, and so markedly in America, that all lines of water-shed wholly disappear, and the rivers flow confusedly together, without any system, and in obedience to no law.

Some rivers come down the sides of high mountains in torrents, then course around in a long, winding course, turning out for all obstacles, and at last find the sea.

Others are entirely unlike them. The Ganges flows from the south side of the Himalaya Mountains, and courses along their base, following the direction of the chain in a southeasterly direction, till it reaches the Bay of Bengal. The Indus springs from the north side of the Himalaya, flows northwest over the plateau of Little Thibet as far as Iskardo, then breaks through the whole chain to pour itself out upon the lowlands of India, the Punjaub, and Mooltan. Dashing its way through the most formidable barriers, it is entirely unlike the gentle Ganges, which pursues its tranquil course through the plains, meeting no barrier in its entire length. The Indus, so long as it remains north of the Himalaya, traverses a plateau 10,000 feet above the sea; while the Ganges, even at Delhi, is but 1000 feet above the sea. Both rivers, although represented in precisely the same way upon the maps, have an entirely different physical character.

The same difference in structure occurs in the streams of other continents, and even in those of Central Europe, though on a less colossal scale. There are, therefore, classes of rivers, and they ought to be just as sharply discriminated as the classes in botany and zoology.

Plateau streams, such as the Danube, as far as the Lower Austrian and Hungarian plains, and the Saone, down to its confluence with the Rhone, pass through high, uniform plains with little fall. They are genuine mountain followers, springing from the verge of the chain and crossing along its base, the Saone taking the west side of the Alps, as the Danube does the northern, and the Po the southern.

The rivers which force their way through mountain ranges form a second class. The Rhine, a free child of the Alps, from its source to the sea, breaks through all

the ranges up to the Jura; then it forces a path through all the mountains of Central Germany, till it comes to its lower course. It may, therefore, be classified with the Indus. It leaves the Alps suddenly at Bâle, and opens a new and romantic way through no insignificant obstacle, and is everywhere a conqueror. That is the peculiarity of the Rhine.

Two streams of analogous nature, though less marked in their characteristics, are the Elbe and the Weser. But these both rise, not among the Alps, but amid the German mountains. They lack, therefore, the exceedingly romantic character of Alpine rivers; but they do not lack in picturesque scenery, and this they owe to the obstacles which they pass. The Elbe has broken its way from the Bohemian ridge through the so-called Saxon-Switzerland, as far as Meissen, and the Weser from the fissures of the Werra and the Fulda to the Porta Westphalica. The Elbe and the Weser make, with the Rhine, the triad of Central European rivers, which have broken a pathway for themselves through mountains which impeded their course.

A third class of rivers are those which encounter no obstacles, and flow in a placid stream from the source to the mouth. They extend in Europe from the Vistula to the Ems, including the Oder and excluding the Weser and Elbe, and from the Rhine along the whole Atlantic coast of France, embracing the Seine, Loire, Garonne, and the Adour—all of these having, in greater or less degree, the same hydrographical character.

From these can be still further discriminated the subordinate coast rivers.

To a fourth class belong all those tributary streams, of whatever size or length, which agree in possessing no

independent character, and do not pour their waters into the sea through their own mouths.

The application of this system of classification can be applied to the streams and their accompanying terrace lands in the other continents. But these observations may suffice to indicate the general principles which we would apply to the study of rivers, and leave to the student their further application.

Review.

The great typical forms already considered, highland, plateau, mountain, lowland, terrace, and river, which all claim so large a share of attention in studying their physical characteristics, are no less worthy of careful attention, in consequence of their influence on human culture. Our account would not be complete without devoting a few pages to the consideration of the manner in which nature and history have reacted on each other.

The most elevated highlands, the loftiest plateaus, uniform in their aspect, immense in their extent, isolated, without trees, having the thin soil characteristic of steppes, and useful only for grazing, are the home of the primitive nomadic races. Without forests and without shelter, without valleys and without water-courses, with sandy and rocky soil, covered with a scanty vegetation, they serve only to supply food for the gregarious animals which follow man, and to furnish a home to wandering tribes of herdsmen. Instances are found in Central Asia, in Toorkistan and Persia, in Central Africa, including the Galla tribes and the Abyssinians. So, too, among the high plateaus of America, the home of the primitive Aztecs. From such places came the first movements of emigration; from the high plateaus of Central Asia came the wandering

Persians, Huns, Mongolians, and Turks; and the same course of emigration was witnessed among the negro tribes of Central Africa, proceeding from the Galla tribes. The lower highlands, less colossal in size, of more moderate height, and of more genial temperature, have at all times reached a certain low stage of culture, after giving a home to the nomads from the higher plateau; but have never developed that culture to any considerable extent. We find examples of this in the high terraces of Bootan, the Deccan, and Persia; in Africa, among the Atlas mountains; in Abyssinia, in the ancient Greek Arcadia, in Castile, in Arvernia, (Auvergne,) in Gallia, in Hesse, in the Eifel, and on the Valdai hills.

In the exceedingly complex, subdivided, and romantic mountain districts of the globe, the races have attained, by virtue of the variety of their resources and the energy of their stock, to the highest results of civilization, and have manifested the most independent and progressive spirit. In such regions, hunting, working in wood, the settled life of shepherds, working in metals, agriculture on such terrace lands as those of Nepaul, Cashmere, Palestine, the Lebanon, Apennine, and other ranges, fruit culture, tilling vineyards, the cultivation of all kinds of industry, as in Central Germany and in most regions of the temperate zone, develop most thoroughly and speedily the culture of a people. In such occupations men learn to lean more on each other, and grow into that diversity of occupation and division of labor, which are the latest results of civilization. The Zend, the Sanscrit, and the Persian nations which people the fertile tracts at the base of the Himalaya Mountains, from Maghada, Lahore, Nepaul, and Cashmere, as far as Persepolis and Hamadan, Susa and Shiraz, the inhabitants of the hill country of Palestine and

Syria, those of the Tehama range of mountains in Arabia, those in the moderately elevated meadows of Gondar, as well as those in all the European Alpine lands, Switzerland, Tyrol, Styria, as well as the inhabitants of the mountain region of Peru and Mexico, all attain to an early and considerably advanced state of civilization. Other nations have found in mountains asylums in time of danger—the Tsherkeses and Ossetes among the Caucasus, for instance, the Basques among the Pyrenees, and the Gorals among the Carpathians..

The lowlands, as soon as the water had left them enough to make them habitable, have become, from the first, the abodes of a teeming population; and there has been the same blending of races in the most ancient as in the most recently settled, in China as in Texas, and, in truth, all North America. Often these inroads of population have been a source of injury, as has been the case in the northern Siberian plains, where the Finnish tribes have made their homes, and in the waste of Sahara, where the Barbarian tribes, the Bedouins, the Tibboos, and the Tuaricks have made their retreat.

On the fruitful terraces, along the middle course of rivers, the earliest fixed habitations and ripened culture have been attained. Through the traditional handing down of past results, and by the habits of peace, their inhabitants have more thoroughly subjected nature and advanced to a higher state of civilization than the dwellers in the interior, away from the rivers. It has been the same, in a great measure, with the lower course, as, for instance, in Egypt, Mesopotamia, China, and Bengal; and in Europe, in Lombardy, Holland, and the Netherlands, where, to the efforts to recover land from the sea, have been added fishing and commerce. On such fruitful tracts as

the mouths and middle courses of rivers water, nations could find a permanent home, and pass quickly to all liberal and refining arts and occupations. This is clear, from the instances of the eminent monarchies of the East, Meroe, Thebes, Memphis, Babylon, Nineveh, Bagdad, and Mosul. So, too, on the Indus and Ganges, in the domains of Taxila, Maghada, Benares; and later in the great empire, whose centers were Agra and Delhi. China has arrived at its highest civilization in the fertile district between its two greatest rivers. Greece and Rome are marked exceptions. Their progress they owe, not to great river basins, but to their peninsular form in the middle of the coast of a delightful sea, full of islands and surrounded by lands in a greater or less advanced state of civilization. England's peculiar maritime position has given it its wonderful vantage-ground for progress in all human culture.

In the east of Europe, the basins of rivers have exercised the same influence, to a certain extent, that has been hinted at above; and Moscow, Kiev, Cracow, and Warsaw remain the seats of a civilization which, rude as it was, owed its existence to the physical conditions of the great Sarmatian river systems. In western Europe, the less marked features of the country have contributed to the peculiar historical development of the continent. The rich deltas have become the granaries for a large part of the population, allowing industry to flow into other channels besides agriculture. The sea-faring habits of the people along the coast have broken up and done away with what is special and provincial, and have conferred a cosmopolitan manner of living upon the entire population. It was the same with the Phenicians in ancient times, with the Portuguese in the middle ages, as it has been with the English, Spanish, and Dutch in modern days. Fishing,

navigation, and trade have become permanent necessities of civilization. In the heart of continental Europe, the rivers have had a great influence on the progress of nations; the North German streams have extended their effect from the abode of the ancient Saxons along the Baltic as far as the home of the Salic Franks on the Scheldt, Seine, and Loire; the Danube, with its complex and important system of terraces and lowlands, has opened communication between South Germany and Hungary, Wallachia, and the East. The Vistula, Oder, Elbe, and Weser have connected the homes of the old Sclavic population with the Scandinavian coasts and the land of the Angles and Saxons at the neck of Denmark, to the equal advantage of both. The great terrace system of the Rhine, embracing the Odenwald, Hardt, Spessart, Taunus, Hunsrück, Eifel, and the Siebengebirg, has thrown into the most active industrial and commercial relations the whole district which it waters. It opened a way to the Romans in their conquering advances before it did to the tribes of Helvetia, Gallia, Germania, or the Lowlands: it sundered those tribes, and kept them from preying upon each other; but, in the advance of civilization, it has become one of the strongest bands to knit together the central countries of Europe.

The Danube, with its extensive terrace lands, faces the east, and has, therefore, very different relations to European history from the Rhine. It is a double-headed river, and one of its head-streams, the one which bears the name of the river proper, extends almost to the Rhine basin; while the other, the Jura, has its source in Grisons, and hard by the head-waters of the Rhine. As the Danube connects the Caspian and Black Sea basin with western Europe, and the largest part of the Asiatic immigrations

have followed its course, the Danube has become the great avenue between Europe and Asia. Celts, Teutons, and Romans were mingled even before Christ, in Noricum, Vindelectia, Bavaria, and Suabia. How many tribes may have been crowded westward by these, is unknown to us. The same fate has happened to the people who settled there before Christ, and the inroads of the Huns, Goths, and other tribes of similar origin, scattered the older inhabitants over all Central Germany. We know, too, that Sclavic, Hungarian, and Turkish incursions followed, each one dispossessing wholly or in part the one which preceded it.

All great rivers and river systems have had a similar influence on the course of civilization. There is not a single type feature in the world which has not contributed its part to the advance of the human race; no one is without its place and its function.

PART III.

The Configuration of the Continents.

ALL the divisions of the earth, taken together in their internal and external connections, in their mutual action and reaction, constitute the unity of the globe, and make apparent that it is a simple organism, designed and created by divine skill, and intended to be the home of a race whose culture should, in the course of centuries, unfold from the most simple beginnings to the most complex and elaborate perfection.

We have already seen that the surface of the earth is naturally divided into three typical features—highland, lowland, and the transition terraces between them. From the vertical and horizontal combination of these result the most of the geographical forms which are the subject of our study. They form what we may, for convenience, call the bas-relief of the globe.

At the creation of the earth every great continental division received (as every other organism has, regarded by itself, and not in relation to the greater whole of which it forms a part) its own special form. Each continent is like itself alone; its characteristics are not shared by any other. Each one was so planned and so formed as to have its own special function in the progress of human culture. This may be seen by reviewing the history of

the past; this may fairly be suspected yet to be in the future. The individuality of each continent raises it to a place where its characteristics give it an independent character, and a capacity of development of itself, up to a certain point, but never beyond it. The continents are never to be regarded as high, dead masses of land, but as vital and effective instruments, working upon each other ceaselessly, and helping each other to attain the consummation intended in the counsels of the Divine Mind. The unity of the earth, the unity of the continents, the unity of every physical feature of the continents, and the building all up together in a perfect symmetry and mutual adaptation of parts, is the crowning thought of Geographical Science.

The study of first causes has no less clear illustrations in the course of our investigations than elsewhere. It is the task of science to show the nature and mutual relations of all the subjects which fall within the scope of Natural History. The nature of the parts is only understood from a comprehension of the whole; not the reverse, however. That is a most just saying of Plato. The knowledge of the universal cannot proceed from a knowledge of the special. As the part is formed only in view of and on account of the whole, in its study, dissociated from the whole, it becomes a mere unit and independent existence. From understanding the solar system, we might arrive at a knowledge of the motion of the earth; and so, from a knowledge of the earth, we may advance to its continents, their relations, the characteristics of the different natural divisions, their subdivisions, their phenomena, and their living organization, embracing man, animals, and plants.

The external formation of the globe, or what we may call

the configuration of the continents, rests upon two characteristics—the horizontal and vertical dimensions.

1. The horizontal dimensions are designated by the sea-line boundary—the geographical limitation.

2. The vertical dimensions—the physical limitation—are defined by the elevation of terraces and highlands, and they exhibit the greatest diversity of phenomena.

The horizontal dimensions supply most of the material for our elementary compends for political geography, which seldom make much account of vertical dimensions, and which, by no means, penetrate to their real value. They are commonly held to be a side-matter, to be touched lightly upon, or wholly cast aside. But both must be thoroughly studied; for they are mutually dependent, and are never found divorced in nature. In order to understand them in their true relations, we will look at them in their general aspect, discussing first the horizontal extent of the continents, then their vertical elevation, so far as that has not already been treated. After this twofold investigation, the character of each continent and its subdivisions will appear in its true light.

On account of the importance of thoroughly understanding the articulation of great districts, in contradistinction to a mere division, which implies no organic and living correlation of parts, and which gives over to mathematics, political history, and fortuitous circumstances the duty of explaining geographical phenomena, it is instructive to trace the footsteps of our science back to some of the earlier conceptions.

Eratosthenes and Polybius were aware that the south of Europe was a series of peninsulas, the first of the two speaking of the great peninsulas of Spain, Italy, and the Peloponnesus, the latter adding allusions to the smaller

Grecian peninsula of Sunium, the Thracian on the Bosphorus, and the Tauric Chersonesus, now known as the Crimea. Strabo got a clearer insight into the significance of these forms, (whose meaning Hipparchus had already tried to explain,) by discussing them according to the sea basins which they separate. Thus the Spanish peninsula separates the Gulf of Cadiz, at the Pillars of Hercules, from the Tyrrhene Sea; Italy separates the Sicilian Sea from the Adriatic; the Peloponnesus separates the Adriatic and the Euxine. This view, though apparently simple, was really profound; for it hinted at the great significance of the maritime coast in developing the civilization of those countries. And Strabo goes on to add that Italy, with its southeastern and southwestern extremities, becomes too pointed, (*διχόρουρος*), and that the eastern peninsulas of Europe are much more jagged and articulated (*ποικίλαι καὶ πολυμερεῖς*) than Polybius had conceived them to be. He entered, therefore, upon a more minute subdivision. Strabo had already (ii. 92) called the Peloponnesus "many-parted," (*πολυσχέδης*), as the Laconian peninsula (*Tœnaron*) is separated from Malea, the Attic from Sunium, and all southern Europe cannot, therefore, be laid out in six parts. Of the north of Europe, Strabo was not in a position to gain any accurate conception. Toward the end of his second book, where he gives his reason for beginning his description at the West, he uses the awkward but significant phrase "polymorphous formation," to indicate the superiority which Europe enjoys in its complex articulation over the other continents. The passage in Strabo runs thus: "We begin with Europe, because it is so intricately organized, and is the most favorable for human culture, and has conferred upon the other continents the most of the advantages which its position has

secured for itself. It is habitable almost everywhere; there is but a little portion of its territory too cold to be the home of man, etc. It enjoys an admirable physical conformation, for it is so perfectly harmonized in the mingling of plains and mountains, (*ὅλη γὰρ διαπεποιχίλται πεδίας τε καὶ ὄρεδιν,*) that the city and the country are brought together, and the people educated by equally favorable conditions to habits of great bravery. Europe is, therefore, complete in herself, (*ἄμταρξεστέρα ἐστί.*)” By this Strabo indicates the independent character of Europe, and its equality with the other continents, despite its smaller size.

Yet for long centuries this insight of that keen observer into one of the most weighty of all the physical conditions of the globe was almost wholly overlooked. At length, however, Humboldt brought it out into new life in its climatological relations, and showed that it is one of the most important considerations to base a study of the distribution of plants and animals upon, as well as for the study of almost all kinds of physical phenomena. In his very instructive paper on the most prominent reasons for the variation in temperature on the globe, published in 1827, he uses the significant expression: “Our Europe is indebted for its mild climate, to its position, and its articulated form.” We have adhered to the same view, and have expanded it in a paper* called *The Geographical Position and Horizontal Extension of the Continents*, as well as in all my lectures.

* This paper may be found in my earlier translation from Ritter. *Geographical Studies*, page 177.—ED.

The Superficial Dimensions and Articulation of the Continents.

We proceed from the more simple to the more complex forms, and begin, therefore, with Africa, which has the most uniform contour of all the continents.

Africa, the true South of the earth, is distinguished from all the other great divisions of the earth by its almost insular form and its unbroken outline. It is separated from Asia merely by the Isthmus of Suez, scarcely 70 miles wide. But it is of altogether more virgin a nature than Asia, and has been encroached upon by scarcely any foreign influence. Africa is a unit in itself; the most exclusive of continents, its periphery is almost a perfect ellipse. With the exception of the single Gulf of Guinea on the west side, the continent is a true oval. Its linear dimensions are almost equal in length and breadth. It extends about 35° on each side of the equator, and is about 70° of longitude in width. The length and breadth are both about 5000 miles.

The periphery of its coast is the most simple and unbroken in the world. A single glance at the map is sufficient to show this. Nowhere are there the deep arms of the sea and the sinuous shores of other continents. The Gulf of Guinea is all. The entire length of its coast-line is but 16,000 or 17,000 miles, not much more than the circumference of a circle whose diameter is 5000 miles. Its coast-line, proportioned to its area, being the shortest on the globe, gives Africa the least contact with the ocean of all the continents, and subjects it to the least amount of oceanic influences.

Thus all individualization of the various phases of life—vegetable, animal, and human—is denied to this continent,

whose extremities, on account of the equality of its dimensions, lie equally far removed from the central point. The similar size and configuration of the two lobes north and south of the equator create no strong contrasts, and give rise merely to tropical and sub-tropical conditions. All the phenomena of this great division, the real South of the earth, in which all the culminations of the tropical world are found, are therefore more uniform than in any other part of the world. The characteristics of race remain in their primitive condition, and have made no progress with the lapse of time: this region seems to be kept as the refuge of a yet undeveloped future. Only general, never individual and special development in the world of plants, animals, nor man, appear upon this stationary soil; the palm, the camel, and their natural companions appear in equal numbers in the northern, southern, eastern, and western extremities; the negro is almost exclusively the only inhabitant of the continent. There is no striking individuality apparent in the culture, stature, organization, nor popular characteristics of its various parts. Even a common foundation language gives rise to mere dialectical differences. A mere sporadic coast-culture gives rise to mere exceptions here and there, and these are generally the result, not of inward progress, but of imported foreign conditions.

Asia, the Orient, is wholly unlike Africa. On three sides it is entirely sea-girt—the south, the east, and the north; on the west only partly, about 1400 miles. On the west, too, it is connected with Africa, but not in a way to insure any necessary relations between the two continents. But with Europe it stands in the most intimate connection, forming a single body with it, of which Europe is really but a great western peninsula. Europe,

the Occident of the Old World, is therefore far less widely severed from its Orient than from its real South or Africa. The history of Asia and that of Europe are woven with a twisted strand; they form a single thread, and their populations are far more closely connected in physical and spiritual organizations than are the people of Asia and Africa.

Asia, instead of being a simple oval, approaches the trapezoidal form, and consequently enters into a new set of relations resulting from its configuration. With the deeply-penetrating gulfs and bays and seas which sink into its trunk, the prominent peninsulas are in direct correspondence, marking in an especial manner the eastern and southern coast, but not lacking on the northern and western. These peninsulas are to be regarded as the limbs of a great central continental trunk. The eastern ones are the Tchoktchee foreland, the peninsulas of Kamchatka and Corea, and the Chinese foreland. The southern ones are the peninsula of Farther India, including Tonquin, Siam, Malacca, and Birmah; the peninsulas of Hindostan, or Deccan and Arabia. The western limb is the peninsula of Asia Minor or Australia. The north-east of Asia is less articulated; still it has a number of arms pointing southward—the Sea of Kara, the Gulfs of Obi and Yenisei, for example. The whole Siberian coast even is far more serrated than that of Africa, where it is an almost unbroken line.

Still, there remains in the interior of Asia a broad and long mass of the continent, which is penetrated by no seas. It is to be regarded as the real trunk, and preponderates immensely over the area of all the confined projections. Asia is, therefore, a trunk with profuse richness of articulation. Africa is a trunk without articulation: a mere compact continental mass.

The immense influence which so complex a coast form has upon all physical phenomena and on all organic life is evident. Far greater results must come from the mutual influence of sea and land than from unbroken land; far more numerous influences upon the climate, and upon plants, animals, and man. Even the changing geological structure of the coast-line must have an effect, when blending with all these other influences, greater than it would have in the interior. Every part of the coast has become different from every other part, with a different hydrographic and climatic character; and the great increase of races of men, and species of plants and animals, was a natural result. While Africa remained limited in all its relations, and destitute of any richness of variety, Asia has always enjoyed an amazing fertility of resources. Instead of the three races or species of man found in Africa—Negro, Berber, and Caffre—many are met in Asia, all different, Tchooktchees, Kamtchadales, Coreans, Chinese, Malays, Bermese, Hindoos, Afghans, Persians, Arabs, and Armenians. And these belong merely to the coast-line.

But the contrast of the great central region to the broken coast is so great and complete, that the advanced culture along the sea-line has not penetrated far into the interior, nor changed the habits of the nomadic tribes which fill Central Asia, and whose representatives we have in the Mongolians, Toorkomans, Kirgheez, Bukharians, Calmucks, etc. Still less could it reach the distant north, to which, with all the splendor which we associate with everything oriental, the civilization of the southern coasts is utterly wanting. To this element of superficial size, the immense and almost insuperable obstacles which Nature has placed so thickly in Asia may be added, and also the immense variety of natural productions which

climates so different as those of the different parts of the continent exhibit. Extending from the equator to the north frigid zone, Asia affords a home for the most diversified kinds of plants and animals, and shows, too, hardly less variety in its eastern and western extremes than in its northern and southern. The characteristics of the Chinese flora and fauna are very widely different from those of Hither Asia. In the east, we have the sago-tree and the tiger; in the west, the date-palm and the lion. The north gives us moss, the coniferæ, and the reindeer, in contrast with the bread-fruit tree, the sugar-cane, the broad-leaved banana, the elephant, rhinoceros, tapir, and monkey of the south.

The inexhaustibleness of the Asiatic continent is not more visible in all this wealth of productivity than in the abundance as well as the variety of human life. Though Asia has been the mother of the world, and has sent out so many and so eminent races, it has not been to the depletion of the parent country. In race, figure, color, manner of life, nationality, religion, political and social bonds of union, forms of government, culture, language, it is so richly diversified, that no continent, viewed historically, can be compared to it. Asia seems to have been created to send forth its fruitful scions of life to all the other great divisions of the earth.

Europe, the Occident. The smallest of the three continents of the Old World, its superficial contents are the largest in proportion to the amount of coast-line. Only on the east side has it a land frontier; and there it has its widest extent from north to south. Like Asia, it is bordered on three sides by the ocean. Asia seems like a mighty trunk, at whose western extremity the broken and serrated occident is found, advancing in breadth from

north to south, but articulating into arms of various size from east to west, till it loses itself in the peninsulas of the Atlantic coast. The nearer to Asia, the broader is Europe, and the more akin to the Asiatic character; the farther from it, the more minute become its subdivisions, and the more varied its character.

Taken in a general way, the proportion of the truly continental part of Europe to the maritime districts is much less than is the case in Asia. Its contrast with Africa is, of course, yet more striking.

Europe begins at the east, at the foot of the Ural and Caucasus, and at the steppes of West Asia. It does not take, as Asia and Africa do, (which are alike in this,) a trapezoidal or oval form, but in its linear dimensions there is a great difference between its length and breadth. By the diminution of its width, as we go westward, and by the increase of its articulation, the number of its internal relations increases toward the Atlantic. A great falling off in the oriental character which has largely encroached upon Russia, and a constant increase of an independent spirit, is the sure result of natural conditions, and is experienced in all life and in things material as well as intellectual and moral. The configuration here wins a palpable victory over mere quantity, and the exceedingly varied coast gives to all European institutions their distinctive character.

Beginning with a breadth of about 1400 miles at the east, the continent gradually diminishes in width to 1000, 500, and even to 250 miles. Its first narrowing is visible between the Gulf of Riga and the Bay of Odessa; the next is between the Baltic and the Gulf of Trieste; the next, between the Zuider-Zee and the Gulf of Genoa; the next, between the English Channel at Calais and the

Gulf of Lyons ; and the last, between Bayonne and Perpignan.

With almost three times as great a length as breadth, Europe extends for a distance of over 300 miles from the southern part of the Ural chain and from the Caucasus to the extremities of the bold coast of Spain and Portugal, Capes Finistère and St. Vincent. In this way the continent assumes very nearly the form of a right-angled triangle, the right angle lying at the Caspian, the base extending westward to Cape Finistère, the perpendicular running northward along the Ural Mountains to the Vainats Straits, and the hypotenuse connecting the two extremities. The area embraced within this triangle would be not far from 2,200,000 square miles. Such a triangle, however, is not exact,—it is but an approximation to mathematical precision ; but it is clearly enough marked to be traced upon our map, or, as a spherical triangle, upon our globes. All geographical forms have only a more or less remote approach to mathematical exactness, but enough to aid us very much in representing them and showing their relations.

Almost all the greater and really important extremities of the continent lie outside of the triangle above indicated ; and this method of treatment only serves to call attention to the great central mass, which would otherwise be in danger of being overlooked, in view of the immense value and influence of the countries on the coast and beyond the triangular line of demarkation. It needs but a glance to see how the projecting shores have marred all the theoretical precision of such a line.

The coast-line shows itself directly subject to almost boundless diversity. Toward the west the independence of each peninsula increases, the more evidently and promi-

nently according to its distance from Asia. Not articulated on two sides alone, like Asia, the east and south, but on all three of its sides exposed to the ocean, the broken coast-line is universal in Europe,—even toward the colder north, where its peninsulas and adjacent islands almost inclose two seas, the North and the Baltic. The advantage which this gives to Europe over Asia in respect to the development of its more northern regions, is very great and evident.

We will enumerate the leading peninsulas of Europe :

Kola, on the White Sea, between Lake Enara, the Varanger Fiord, and the Bay of Kandalaska, pointing westward.

Scandinavia, embracing Norway and Sweden, with an area of more than 350,000 square miles, a tenth of all Europe, connected with the main land by the isthmus of Finland, but otherwise girded in a great bow by the Atlantic, the North Sea, the Baltic, and the Gulf of Bothnia, and pointing southward.

Jutland or Denmark, beginning at the Elbe and the Trave and running north, embracing about $\frac{1}{16}$ of Europe, between the North Sea and the Baltic, low and flat.

The subdivided peninsula of Holland, between the Rhine and the Ems, a flat plain, looking to the north.

The peninsula of Normandy and Brittany, between the Seine and the Loire, a rocky granite formation, jutting out into the Atlantic and faced by bold precipices.

Spain and Portugal, embracing about 220,000 square miles, about $\frac{1}{16}$ of Europe, rhomboidal in shape, almost insular in position, turned southwesterly, its surface a series of constantly rising terraces.

Italy, embracing $\frac{1}{33}$ of Europe, between the Alps and Sicily, and traversed by a mountain range.

Turkey and Greece, or summing it more strictly under

one word, the Grecian peninsula, between the Danube and the Morea, a most minutely divided region of plateaus and mountain chains ; in truth, the most articulated peninsula in the world, and embracing $\frac{1}{15}$ of Europe.

The Crimea, a rhomboidal peninsula, turned to the south—its northern half a flat steppe, its southern a high plateau—the only peninsula of southeastern Europe projecting into the Black Sea.

Every one of these peninsulas differs from every other in shape ; every one has a distinct individuality imposed upon it. Within the smallest compass on earth, relatively speaking, there is found around Europe the very largest variety in its articulations. The Grecian peninsula finds its only superior on the northwest of Europe, in the coast of insulated England.

By means of this characteristic separation of so many more or less individualized parts of the continent through the agency of arms of the sea, the coast-line of Europe has been prolonged to an extraordinary length. The areas of the three continents of the Old World are as follows in round numbers : Europe, 3,500,000 square miles ; Africa, 11,800,000 square miles ; and Asia, 19,300,000 square miles. Although the superficial contents of Africa are three times that of Europe, the length of the coast-line is so far from being equal, that that of Europe is much the greater, being 25,400 miles. The Asiatic coast-line is about one-third longer still, 32,900 miles ; but, as the area of Asia is more than five times that of Europe, a great part of the Asiatic coast-line, that on the north, from Nova Zembla to Kamtchatka, must be considered as unimportant in relation to the development of the resources of Asia.

Europe is, therefore, that continent of the Old World

which has relatively, and I might almost say absolutely, received the largest coast-line of any, encompassing a distance of 25,400 miles. That is to say, the coast-line of Europe, extended in a straight line, would pass around the globe and coincide with the equator. To this admirable feature may be added its favorable relation in situation to the various oceanic and wind currents, and its magnificent supply of harbors, the result of its articulated coast, all of which have made Europe the mistress of the seas. Within modern times, the island group of Great Britain and Ireland, the richest in harbors, is to the continent what, in ancient times, the Greek peninsula was, with its wealth of inlets, which gave it the command of the Mediterranean. A rich gift this has been to the smallest of the continents of the Old World, to equalize its condition with others. The providential wisdom which "sets one thing over against another," is clearly manifest in this. Europe, though in the center of the great continental land-mass, becomes the most maritime of all, the most approachable of all; or, in other words, its countries and its peoples are the most closely connected with the sea of all in the Old World, because they stand in the most unbroken contact with it.

Thus we discover the characteristic type which was impressed on Europe from the very first. Its relation to the world could not be understood by the ancients, as to them half of the earth lay in unbroken darkness. Only by experience, only by the advance of civilization, and by comparison with all the other continents, could this insight be gained. Doubtless many similar relations yet remain unknown and unsuspected, which will some day come to the light. The earth, as a planet, is only a grain of seed-corn sown by the Creator, enriched with powers.

of unfolding to infinite perfection in the unexplored future. What we now perceive are only the elementary principles—our knowledge only a motley; but even this is not without its uses, and is worthy of patient mastery.

Europe, so broken in its coast, and rifted far toward its center by arms of the sea, has been affected in all its civil and social history to a very great extent. This is the first natural condition of its progress, the true physical basis of the fact that, upon the most limited of the continents, the greatest historical diversity has sprung up. It is not absolute size, but relative, which gives the pre-eminence; not the raw material, the mere mass, but its articulation, its form, which here, as everywhere, gives mind the mastery over matter. As in the animal and vegetable world there is, amid all the diversity of forms, a constant advance from a lower to a higher plane, manifesting itself in the complexity of the organs; so, in the so-called unorganized side of nature, we see the same characteristic as soon as we have grasped the whole mutual system of adaptations. The most general study of the differences between the continents exhibits an analogous harmony and correlation. As the simple, broad-leaved, solid cactus, or bunch-trunked euphorbia, (peculiar to the dry sand steppes of America and Africa,) appear branchless and without foliage,—the lower and undeveloped forms of vegetation,—so, too, the regions to which they are indigenous are the unbroken plains of North America, or the plateaus of still less broken Africa.

The broken coast-line of Asia and Europe is analogous to that higher development which we find in the palm and in the full, round crown of the European fruit-tree, which bears blossoms and fruit as far as the very extremities of the branches. In the animal organization, the articulation

of Europe is to be compared with the complex hand of man, so far superior to the prehensile organs of lower creatures, that Buffon saw in that feature alone the manifestation of man's place among the animal kingdom.

If we look out over the earth, we see that the limbs of the continents, so to speak, the coasts, the peninsulas, and the adjacent islands, are the most favored places of all for civilization to find its true home upon. With the degree of diversity in the structure of a country, the value of its organisms advances. In this respect, Europe may be considered as the branches and foliage of a great tree, whose trunk and root are to be traced to Central Asia, Africa being a stunted side-shoot. Or, to compare the continents to a still higher class of forms, Europe may be called the Face of the Old World, out of which the soul of humanity could look more clearly into the great and promising future.

We repeat it—it is not absolute size, it is not the mass nor the weight of the material, it is the form, in its greater complexity, which determines the fate of nations and decrees the advancement of man. This gift, in its full measure, has been conferred on Europe. In its complex articulation lies still another characteristic of Europe in contradistinction to the other continents.

If in Africa the coast offers no contrast to the interior, and both remain on the same low plane of development, Asia, on the contrary, displays a perfect antagonism between its central regions and its sea-board. The territory of the Mongolians, the Tartars, and Toorkomans has always remained at the very lowest stage of civilization. The sea-board, on the other hand, has witnessed the growth of a number of isolated nations, who, without the help of mutual dependence, have arrived at a considerably high

degree of culture—the Chinese, Malays, Hindoos, Persians, Arabians, Syrians, and Armenians. But their influence could not penetrate to the compact interior, to transform its nature, nor modify its nationalities. Individual progress in nations, however high it may be carried, can never contribute much toward any real penetration of the interior of so vast a region as Central Asia.

Europe shows in its construction and the relations to which it gives rise characteristics exactly opposite. Being far less massive, the proportion of its extremities to the undeveloped interior is much less great than in Asia. From this, it results that the central part does not prove a hinderance to civilization, viewed physically, hydrographically, or historically; it nowhere serves as a barrier, but rather as a mediator, and a means of communication between the extremities. This has given Europe a character exactly opposite to that of Asia: its North and its South are united, its East and its West; they are not like antagonistic poles, but extend to each other friendly hands. In Africa, the greater part of the interior lies absolutely without contact with and relations to the coast. In Asia, there is a much larger portion of the interior equally without connection with the sea-board, and remaining up to this day in its primitive barbarism.

Symmetry of form gains in Europe a clear advantage over mere mass. Europe, the smallest of the continents, was destined to gain precedence over all the rest, Asia included. As Asia, lying within all the zones, colossal in size, and most plentifully enriched with the gifts of nature, was fitted to be the nursery of supply for all other parts of the world without impoverishing itself; so Europe, limited in size and confined to the temperate zone, but most complex in its subdivision, having a great diversity in its ocean

inlets, as well as in its hills, valleys, plateaus, and mountains, yet, without great extremes, has been especially fitted for the reception of stranger races, and for the development of their energies and the advance of their culture. The symmetry and harmony of Europe have constituted the true home of all varieties of national character, and have adapted it to their mutual action, and to the transfer of their distinctive character to one another.

Throughout the entire center of Europe there is an intimate connection with the sea-coast and with the extremities, with the least possible disadvantages. This is accomplished by those sinuous river-courses whose analogies are to be found nowhere in the adjacent continents. The very broadest part of Russia even is intersected with large navigable rivers; and the west and center of Europe are not less richly supplied with these lines of communication, whose starting-points lie often close together, as in the case of the Danube, the Rhine, the Po, and the Rhone. How different is this from the hydrographical system of Central Asia, where the sources of the eastern rivers lie thousands of miles removed from those of the western rivers, and where the rivers of the north are separated by almost as great distances from those of the south!

To what nature has given to Europe man has largely added, seeking by means of canals and railways to make the whole continent subject to him and auxiliary to his needs. In this way the interior districts have appropriated to themselves the advantages of the sea-coast, and the distance which it has placed between itself and Asia and Africa has only been increased. Nature first gave Europe its vantage-ground, and man has gone on from that point and doubled the gifts of nature.

Great peninsulas stretch away into both the great inland seas of Europe—that of the North and that of the South; the Danish and Scandinavian peninsulas into the complex, and yet, physically speaking, single body of water, embracing the North Sea, Baltic, and Gulf of Bothnia; Spain, Italy, and the Grecian peninsula extending southward into the Mediterranean. In the latter there is the greatest contrast between the deeply-indented northern shore and the bare, sandy coast of the African side. In just as great contrast is the uniformly unbroken sea-line of northern Siberia, compared with the articulated shore of northern Russia. How entirely different would the development of northern Asia have been, if a Siberian inland sea had penetrated to the very foot of the Altai, as the seas of northern Europe have pierced to the center of the continent! And had the shallow Syrtis cleft northern Africa as far as Lake Tchad, as the Adriatic has done on the opposite coast, Central Africa would not now be a *terra incognita*.

The northern as well as the southern extremities of Europe, so far as they are projected into inland seas, have received an equal size and equal natural advantages, each of its own kind, so that, conditioned by its own peculiarities, its population have helped it to attain its rightful place, and an individuality independent of continental influences. The abundant resources which each of these extremities enjoys have insured it, in a physical as well as historical view, an independence which has reacted favorably upon the whole continent. What a debt does not Europe owe to the Greeks, Italians, Spaniards, Dutch, Danes, Scandinavians! How entirely different would the whole development of the shores of Europe have been, had they been bold, inaccessible rocks, an unbroken line of coast,

like Uralaska, or the smaller Asiatic peninsulas of Kamtchatka and Malacca! And where would the accomplished European stand to-day, in comparison with his black neighbor on the south, were it not for the articulated coast-line of the continent which gives him his home?

And still there remains, out of the inexhaustible richness of nature, one leading feature to be taken into account. To estimate it properly, we must pay attention briefly to the islands of the three continents of the Old World.

Islands.

Europe, as a continent, is distinguished by its adjacent islands. Following the irregular coast-line of its many extremities, they lie along, in greater or less number, the satellites, so to speak, of the main land. They are scattered almost everywhere, yet not distant from the coast, like Iceland, but within sight of the shore. In character they resemble the adjacent coast, and form a true part of the main land, except in the one fact of separation. Strabo even called Sicily an insular continuation of Italy, and discriminated between islands found in mid-ocean and those found near the coast, calling the former pelagic and the latter littoral islands. These he regarded as having been at some previous period rent from the main land. The coast islands are by no means, like many of the pelagic islands, mere rocky groups, thrown up by volcanic convulsions, or small, desolate, barren ledges. They are very diverse in character: some are fertile single islands, like Sicily, Candia, Bornholm, Rugen, Negropont; some are double islands, like Britain and Ireland, Zealand and Funen, Corsica and Sardinia; some are island groups, like the 3 Balearic islands, the 3 Maltese islands, the 20 Ionian islands, the 67 Orkneys, the 90 Shetlands, the still

more numerous Hebrides, the Aland group, and that of the Grecian archipelago. They are generally of very large size, in comparison with the continent to which they are adjacent; a characteristic not only very rare in islands, but which must exert great influence. They are to be viewed, therefore, as continuations of Europe, not as lands sundered from the main land; they are to be considered as its sea-ports, and the mediators between Europe and the other continents.

In round numbers, the islands of Europe embrace about 175,000 square miles—a twentieth of the continent.

This amount of insular territory has given Europe a great diversity of relations, and has contributed much to its ethnographical character. Imagine only England and her whole group struck out of existence. What impoverishment it would bring! The Danish peninsula, without the adjacent islands of Funen and Zealand, were a mere tongue of sand. Without Sicily to furnish grain, Rome's history had been entirely different from what it was. What a change it would have made in the development of Italy and Greece, had the Cyclades and Crete not served as a bridge, over which the civilization of Hither Asia might pass! Yet these islands, with their inhabitants, do not stand in necessary dependence on the contiguous main land; they have often in themselves the conditions of independent growth and prosperity. And yet the geological qualities and general features of islands may agree very closely with those of the land hard by; as is the case with the British, Danish, Italian, and Grecian groups. Southern England is a continuation of northern France, Picardy, and the Netherlands, as the geology of these districts shows. Sicily is a continuation of the volcanic soil of Calabria, and Candia of the Morea.

Hence the possibility, despite the separation of islands from the main land, of a close connection in the habits, manners, and culture of the people, thus separated, depending as they do on a common soil, and having the same industries in common. It would be entirely different in Great Britain, for example, if the south end of England were geologically formed like the north end of Scotland. Instead of harmony there would be repulsion, and that mutual interchange of relations would not exist which has so powerful an influence on the whole course of European history.

The remarkable number of islands on the coast of Europe, and their significance and value, formerly escaped attention; or rather their influence on the development of that continent, in comparison with others, was not made a matter of study.

Africa has never enlarged its domain through the aid of adjacent islands. Poor as it is in all coast indentations, it is just as poor in islands. Only a few insignificant ones, which have no close geological connection with the shore, are found here. The sporadic groups found in the Atlantic and Indian Oceans are almost exclusively the product of subterranean forces, and are entirely unlike the stratified lime and sandstone formations of the coast. There is, therefore, no close connection between the inanimate nature of continent and islands and their respective populations; no physical conditions have imposed upon them a common historical development. Only the Canary Islands, southwest of the Atlas Mountain range and Madagascar, could be regarded as at all exceptional to this. But the nine Canaries are relatively extremely small, embracing but about 3000 square miles in all; much too small to exercise any important influence, or to harbor a large popu-

lation. Besides, they are separated from the main land by marine currents, which would prevent any very important reaction, however large the islands in themselves might be. The Cape Verd islands, embracing only about 1750 square miles, stand in yet more unfavorable relations to the main land. So, too, the solitary islands of St. Helena and Ascension, and in the Indian Ocean the scattered groups of the Camara, Amirante, and Seychelle islands, embracing all together but 3300 square miles, and Socotra, about 1750 square miles. Only Madagascar would be large enough to enrich the continent essentially, if it were nearer to the main land. But it is separated from it by the broad and dangerous Mozambique Channel; both, therefore, have remained without mutual relations; their populations are entirely unlike, and there has been no exchange of productions between them. Madagascar is, therefore, only apparently, and by the apparent contiguity of the mass, a neighbor of Africa; but, in reality, *i.e.* as it relates to the organic unity of all the various parts of the globe, it is far more intimately connected by the system of marine currents to the Malayan Archipelago, south-east of Asia, than to Africa.

Entirely different is it with the island system of Asia. The eastern and southern sides are remarkably characterized by the profuse numbers of islands found there. It might be said, that what Africa lacks in this regard, Asia more than supplies. On the Asiatic coast they appear in such vast numbers that they have been called, in contrast with the Old and New Worlds, the Island World, or Polynesia. They appear under the most varied conditions—in long rows, in massive groups, and here and there singly. They begin with the North Polar islands, and pass southward in unbroken succession past the equator as far as the tropic of Capricorn.

The Aliaska chain connects the northwest coast of America with Kamtchatka; it comprises over 100 islands, and embraces about 7660 square miles.

The Koorile island extends to the south as far as Saghalien and Yesso.

The Japanese chain runs southward as far as Cape Corea, and includes the great island of Nippon with numerous smaller ones, embracing an area of 164,000 square miles.

Then follow :—

The Loo-Choo islands as far as Formosa.

The single island of Formosa, 13,000 square miles.

The coast island of Hainan, 16,450 square miles.

The numerous group of the Philippines, with the adjacent islands, 121,000 square miles.

The greater Sunda group, with its adjoining archipelago, 689,500 square miles. Of these, Borneo embraces 295,600 square miles; Sumatra, 167,700 square miles; Java, 54,600 square miles; and Celebes, 72,600 square miles.

The smaller Sunda group, 29,200 square miles.

The scattered group of the Moluccas, with the Banda and Ternate islands, 7950 square miles.

The great island of New Guinea, 262,800 square miles, which forms the transition of the Australian group.

On the south coast of Deccan, the great island of Ceylon, 25,860 square miles.

These rows and groups of islands, embracing an aggregate of 1,095,000 square miles, form a kind of insular isthmus from the southeastern extremity of Asia to the northwest of Australia, though broken by unnumbered straits. If lines be drawn from Sumatra and from Hainan to Cape York, on the north coast of Australia, an

ideal isthmus would be formed not unlike that which connects North and South America. If this insular isthmus be further conceived to have been thrown up by volcanic forces, as that of Panama seems to have been, an addition of 1,095,000 square miles has been made in this way to the most productive portions of the world. So great is the accession of territory that it has become the abode of a distinct race—the Malay—which hardly finds a home at all on the Asiatic shore. Asia has received very little advantage from this vast archipelago. Only the south-east coast has been affected by it; the continent, as a whole, has not been reached by its influence. On the contrary, Australia has been largely affected by it in its productive and ethnographical character. Not only was it first discovered through the agency of these islands, but it probably derives its population from them; it has received many of its animals and plants from them—the sugar-cane, the sago palm, the bread-fruit tree, the dog, and the swine.

In Polynesia, which, in point of size, far surpasses the Antilles group north of South America, we have the most dismembered region on the surface of the globe. It is the highest degree of insulation, of individualization, and results from the extreme carrying out of dispersing causes. The space occupied by the greater Sunda group, with its five seas—the China, Java, Molucca, Celebes, and Mindoro—together with the islands adjacent, the whole lying between longitude 110° and 160° east and latitude 10° south and 20° north, a tract 3525 miles long and 2115 miles wide may worthily be compared with the area of Europe. Such a mass of island groups and single isles, belonging not to Asia with any strict right, but in truth a maritime world of itself, having but the slightest connections with the

adjacent continent, is not to be compared with the island system of Europe, which is bound to the main land by the closest ties.

Were a similar insular dismemberment the universal principle on which the world is constructed, and were there no continents whatever, there would be an entire want of direct dependence in nations upon each other, and a degree of independence which would be fatal to the best interests of man. Europe would be broken up into a number of great islands, like Borneo, and into countless islets. In the conformation of Europe, however, there is the happiest system of compensations, and the most harmonious play of contrasts to be found in the world. The disadvantages of a too great dividing up into islands, as in Polynesia, and of too compact and unrifted a central mass, as in Africa, are alike shunned. Both extremes could not fail to be injurious to the best interests of the population. The fullness and richness of nature might, perhaps, be increased; but the effects on human life could not fail to be bad. Man's highest development does not consist with any extreme in the natural world: it is linked to the action and reaction of contrasts. In Polynesia, the district of extreme dismemberment, the Malays are the least homogeneous of any race on the earth. Malays, Battahs, Dakkas, Horasuras, and Papuas are all engaged in destructive war on each other, and are among the most degraded peoples on the globe. In this region there is the greatest diversity in physical nature, but not in the essential characteristics of man. One point of accord ought not to be passed by: there, where the forces of nature, maritime and volcanic, are on the greatest scale known, the warlike passions of man are on a not less consuming scale. In Polynesia there are the rankest vegetation, the

most fervid heat, the most costly spices, animals very large and rare; but man attains to no such superiority,—he degenerates in worth and takes a low place. Where the three natural kingdoms attain their perfection, man seems to linger in the rear.

In Africa, where there is perfect uniformity in nature, there is uniformity in man; and the negro stock, though prolific, gives no race of high development to the world. Both extremes are equally unfavorable to the advance of man; he must have, in order to expand and take the place to which his possibilities lead him, a sphere of mutual conditions, to which a compact continent like Africa and Central Asia can lay no claim, and at the same time be free from that extreme individualization characteristic of the islands of Polynesia.

Europe lies between these extremes. Limited in area, diversified in surface, and deeply indented in its coast-line, it has experienced all the advantages which a continent needs for its development, and for that historical greatness which Europe has won for itself. Less striking in natural scenery and comparatively poor in resources, its contrasts in respect mainly to the action of its inland seas and rivers over the main land have conduced to the happiest results. It has become the school for the Old and the New World, taking the vitality and the crude gifts of Asia and turning them into channels where they could issue in new forms for the advancement and the humanizing of the race.

The Results of the above Considerations briefly stated.

It will be seen, from what has now been said, that, with an area three times less than that of Africa, Europe (including its adjacent islands) has a coast-line twice as ex-

tended. Without the islands, it is 25,380 miles in length, or the circumference of the earth. The coast-line of Africa extends 17,860 miles; that of Asia 32,900.

The exceedingly varying areas of the continents may now be passed in very speedy review. Europe is but a fifth as large as Asia. It is somewhat more than a quarter as large as Africa; it is almost of the same size with Australia. In relation to America, it stands between Asia and Africa; it makes about $\frac{1}{15}$ of all the continents, and about $\frac{1}{20}$ of all the land surface of the globe; but it is not absolute size, but relative, which determines the importance of a continent; and this twentieth part of all the land on the globe has had paramount influence over all the rest within the past few centuries. The ethnographical character of its population has had great weight in securing this result, and other reasons will doubtless be more apparent in the future.

One of the most important features in the study of the relative importance of the continents is the comparative relation of the main trunk, articulation, and island system to each other. The following table presents this relation as it exists in the Old World:—

Africa:	trunk	1,	extremities	0,	islands	$\frac{1}{50}$
Asia:	"	4,	"	1,	"	$\frac{1}{8}$
Europe:	"	2,	"	1,	"	$\frac{1}{20}$

These are but approximations to the exact mathematical statement; but they serve to indicate comprehensively this important fact. No exact canon now exists for the perfect expression of the relations of the continents to each other, and their physical superiority and inferiority, and its lack is no less felt than it has been in art to express the comparative importance of the organs of the human body in giving a representation of man.

The New World.

America is broken by the Caribbean Sea into a double continent, both parts being of colossal magnitude, although the southern portion is about 2,000,000 square miles less in area than the northern. North America contains 9,055,146 square miles. South America contains 7,073,875 square miles; and both contain 16,129,021. The connecting link is found in the tapering isthmus of Central America, with its 302,443 square miles of surface.

But closely connected as is the northern part of the continent with the southern, in a physical sense, in real connection, so far as man is concerned, they are widely separated. During the three centuries which have elapsed since the discovery of America, the Spanish and the Americans have thought of breaking the connection—of sundering the isthmus. All communication between North and South America takes place by water, absolutely none by land. Even before the navigation of the historical period, there seems to have been no land road opened along the isthmus. The old race of the Caribs passed in boats from the Appalachian mountain land of North America to South America and the West Indies. The Toltecs and Aztecs—the oldest tribes which wandered southward—seemed to have ended their march on the high plateau of Mexico and the vale of Anahuac. The legends of the Incas give us no tidings of their traversing the isthmus and reaching Peru on foot, and it is probable that they reached that land otherwise. The isthmus seems never to have been a bridge, but always a barrier. The great Antilles group of islands appears to have served far more as a means of communication between North and South America.

In respect of contour, both divisions have an unmistakable analogy, which appears at first view. Both exhibit a triangular form, with the base at the north and the apex at the south. Toward the south, too, rather than toward the west, speaking in general terms, the gradual conquests of man advance, and therefore there cannot be in the New World, as in the Old, a striking contrast between the Orient and the Occident. East and west, in the New World, are less dependent on each other; they have more individuality, but with a great preponderance of importance in the east over the west side, by reason of the more favorable situation in relation to the sea, less sharpness and boldness of physical features, and a more scanty population. The west side of America has by no means kept up with the advance of its eastern side. Nor could the more southern shores of America compete with those on the northeast, and supply an analogy to the occident of the Old World; for North America stands related to Europe by ties of the closest nature, by wind systems, currents, a not dissimilar climate, and is far more nearly connected with it than with South America: nor could the latter derive any real advantage from its opposite neighbor, rude and undeveloped Africa; nor has the Caribbean Sea performed any such service for America as the Mediterranean has for Europe, being twice as large in area and far more unfavorably situated to advance the interests of civilization. It is only within a recent period that the Caribbean has become a valuable auxiliary to the culture of the world.

South America is only a colossal right-angled triangle of land, with very little articulation in its shores. The northwest and the eastern angles are sharply defined, and the southern one is very acute, the continent running out

in the shape of a thin wedge. With some modifications, it has the same form with its neighbor Africa, and is just as unvarying in its want of a serrated coast, its sea-line being but 16,000 miles in length, almost the same as that of Africa. Like Africa, too, South America is destitute of peninsulas and adjacent islands; its coast is as undented as that of Africa and Australia, all three of these continents of the southern hemisphere being in strict conformity. Yet South America is capable of great progress: its conditions are very plastic; it is characterized by the size and number of the great rivers which pass through its very center; its flora and fauna are extremely rich. In the fruitfulness of its soil, its division by mountains, and its water system, it holds great pre-eminence over Africa. An effort to connect its great rivers, and thus to make its immense natural advantages of mutual service, seems to promise a far more prosperous future for South America than can be predicted for Central Africa; yet the native population of the country stand on a very low plane of manhood.

The wedge-shaped plateau of Patagonia is not at all benefited, as previous analysis would lead us to expect, by its long coast and by the nearness of the islands of Terra del Fuego. The fruitful island of Tasmania is far more valuable to Australia than is this island to Patagonia, and even Iceland is a more productive neighbor to Norway. The Terra del Fuego group, embracing a territory of 29,000 square miles, although hard by the South American coast, only injures it instead of blessing it, for it imperils shipping and harbors a population so degraded that they have no wants which can stimulate the rudest civilization. With a precipitous, craggy coast, without trees and without grass, covered only with moss, and be-

longing strictly to the polar world, it must give a habitation to the very lowest and most degraded of the human race, isolated from the world, and only casually visited when winds and storms throw mariners upon its shores.

Not every island is to be considered, therefore, as a gain to the adjacent main land. If Terra del Fuego lay at the mouth of the La Plata River, it would have become a valuable auxiliary to Brazil. The worth of an island is relative, not absolute.

The Antilles group is the great insular formation contiguous to Central America. Its area, though comprising 94,700 square miles, is not one-tenth as great as that of the great Sunda group. By situation and physical conditions, it is much more closely connected with North than with South America. The Caribbean Sea is twice as large as the Mediterranean, the one having 801,800 square miles, and the other 1,675,800 square miles. It has been, therefore, more difficult to make the larger tributary to the advance of civilization than the smaller.

North America has entirely taken the palm from South America in the progress of its culture, just as has uniformly been the case with all the continents of the northern hemisphere compared with the southern; and yet the tropical southern continent is far more profusely endowed with the gifts of nature than the temperate northern one. The northern half, on the other hand, enjoys a far greater advantage in its broken coast-line, numerous bays, gulfs, islands, peninsulas, harbors, as well as by reason of its greater want of conformity to a rigid triangular form.

Enlarging, as it does, toward its southern extremity, North America approaches a trapezoidal shape, like Asia, and, as in Asia also, the size of the main body preponde-

rates greatly over that of the extremities. Several of these extremities, too, extend toward the east and south, and only a few toward the west. To the North American peninsulas and islands belong the northeasterly island group of Greenland, (which for centuries was considered to be a peninsula, but which, since Parry's discoveries in 1820, has been known to be a group of independent islands,) Bank's Land, Boothia Felix, Cockburn, Melville's Peninsula, Labrador, New Brunswick, Nova Scotia, and Florida, the latter 59,000 square miles in area.

The northeast of North America is everywhere much cut up by inlets of the ocean, larger bays, gulfs, and sounds. This is the main characteristic of the shore of the northern United States and Canada. As all these open toward Europe, the situation of this whole region has been especially adapted to the most speedy advance in civilization. The pride of the American can no more plume itself on an independent progress than can that of the European; to the former, Europe is the Orient from which he receives, in an already advanced stage, what the European receives from Asia, his own Orient.

The less important peninsulas of North America, and the side most destitute of them, are turned toward the northern Pacific. To this region belong the Russian possessions, the desolate wastes of Aliaska, and, farther to the south, the peninsula of Old California, which has begun, within the last ten years, to play an active part in the world's affairs. But all three of these are capable at present of little independent advance. They must wait till they feel the impulse of the civilization of the older American States, before they take that place to which the newly-organized commercial relations with China and Japan seem to be leading the way.

North America enjoys a great advantage over Europe in the possession of large inland lakes or seas. The prevalence of articulation and of the adjacent islands is not toward the south, but toward the polar and sub-polar regions, (from 40° to 50° N. lat.,) as in Europe. And although many of these islands and peninsulas are as yet but little known, still the progress of discovery has been so rapid within the past few years, that it would seem, by European analogies, that an important history is yet in store for them. For there is a great kinship between these northern regions of America and the Scandinavian and North Russian domains of Europe. And we know well that no degree of cold has ever intimidated civilization from penetrating in the latter to the very confines of the polar world.

As the White Sea, (48,500 square miles in area,) the Baltic, (167,000 square miles,) and the yet greater North Sea, have broken through the northern regions of Europe, so on a far more gigantic scale have the inroads of the ocean rifted and sundered North America. This we have learned in our recent frequent voyages to the Esquimaux regions. Baffin's Bay, Lancaster Sound, Smith's Sound, Jones' Sound, Barrow Strait, Fox's Channel with its uncounted islands, Hudson's Bay with its 499,000 square miles of surface, Boothia Gulf, Victoria and Georgia Seas, Wellington's Channel, Melville Sound, Prince of Wales Straits, and very many other water passages and basins divide those northern districts into a vast mesh of islands and peninsulas. The superficial area of all these tracts is on a colossal scale; even the Greenland group is estimated to include 766,500 square miles. Within the past few years this whole Arctic Sea has been the scene of numer-

ous expeditions of discovery, some of them on a princely scale.

All this shows that North America is fashioned much more after the analogy of Europe than of South America. The analogy would be much more close, if North America were as favorably affected by climatic conditions as Europe. Both continents are washed at the south as well as at the north by great inland seas, and divided up by them in a manner peculiar to them among all the continents. Of this articulation, America, less favored by climate, has much the larger share. By its admirable harbors, and by the action of the Gulf Stream crossing the Atlantic in two directions, America has been specially fitted to receive the population and civilization of the Old World, and to stand in the closest relations with it. In this, united with the arrangement of its mountain chains and the happy characteristics of its river systems, America bears the palm completely away from Asia. In that continent the colossal rivers of the north have no connection at their sources with the head-waters of the great Chinese, Indian, and West Asiatic rivers. It is entirely different in North America, where the St. Lawrence, Mackenzie, Columbia, Colorado, Mississippi, and Missouri flow from the same region, as from a common center, not separated at their sources by an immense plateau, but forming a single river system, from the mouth of one to that of another, flowing in just the contrary direction. We find, therefore, that there, as in North Europe, civilization has followed the water-courses, and has planted colonies as far north as 70° on the coast of Greenland; while in Asia human habitations cease with 65° N. lat.

America seems to be appointed, by its physical conditions, to plant the banner of human progress at the most

northern parts of the globe, and to do for the northern hemisphere what Great Britain, through her colonies in Tasmania and South Australia, with their admirable harbors, is doing for the southern.

Northern Asia seems to have no future indicated for her beyond the sources and upper courses of her great rivers; she seems to depend upon Central Asia and upon Russian Europe for all the scanty culture which she may possess. In its south and east it seems to have within its Chinese and Indian populations the seeds of an independent development, whose results, like those of Arabia, have been transferred to Europe to become improved there, and then to be given to the world. The form of the three great peninsulas, which were the home of Asiatic culture, has been repeated in Europe,—but with how great a difference! The three European peninsulas are not in the tropical zone and near the equator, but are 1400 miles farther north. The two groups—the eastern one in South Asia, the western one in South Europe—each consisting of three peninsulas, are the most valuable auxiliaries the world's civilization ever had. Through their agency Asia in the torrid zone and Europe in the temperate have become what America and Australia are yet to be to the extreme north and the extreme south. The former were for the past, the latter for the present and the future. South America, and yet much more Africa and Australia, seem to be held in reserve for the need of a home where the civilization of centuries yet to come shall expand into perfection. They now are in their infancy; the day only begins to break in them. Furnished as they have been with the most liberal gifts of nature, they must receive a culture of which we as yet have little conception. In what way this can be done, the history of the past reveals. The

art of navigation has, within the past three centuries, given to islands and to continents a new life, and developed relations unknown till then. The very touch of European civilization has already wakened the world to new life; and the oceans, which were once the most impassable of barriers, have become the closest of bonds to draw the earth together, and to further its progress toward the consummation of all history.

THE END

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